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TRANSACTIONS OF THE

SECTION ON

SURGERY

General and Abdominal

of the
American Medical Association
at the Sixty-Seventh Annual
Session, held at Detroit,
Michigan, June 13 to 16, 1916

AMERICAN MEDICAL ASSOCIATION PRESS
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PROCEEDINGS OF THE SECTION

TUESDAY, JUNE 13—AFTERNOON

The meeting was called to order at 2:05 by the chairman, Dr. E. Wyllys Andrews, Chicago.

Dr. Andrews then read the chairman's address, entitled "The Relation of Practical Surgery to the Pure Sciences." No discussion.

Dr. George W. Crile, Cleveland, read a paper on "Practical Results of Newer Methods in Surgery of the Stomach and Intestines." Discussed by Drs. A. J. Ochsner, Chicago; R. C. Coffey, Portland, Ore.; Henry O. Marcy, Boston; John B. Deaver, Philadelphia; Alfred A. Strauss, Chicago, and G. W. Crile, Cleveland.

Dr. John A. Wyeth, New York, read a paper on "Some Observations on the Teaching of the Surgeon." Discussed by Drs. A. D. Bevan, Chicago; John D. Milligan, Pittsburgh; Thomas A. Stoddard, Pueblo, Colo.; H. O. Marcy, Boston, and John A. Wyeth, New York.

Dr. A. Bennett Cooke, Los Angeles, read a paper on "Nitrous Oxid-Oxygen Anesthesia in Major Surgery." Discussed by Drs. W. I. Terry, San Francisco; L. M. Gaines, Atlanta, Ga., and Mr. C. K. Teter, Cleveland.

Dr. Charles N. Dowd, New York, read a paper on "Tuberculosis of the Cervical Lymphatics." Discussed by Drs. John F. Golden, Chicago; Robert T. Morris, New York; W. E. Ladd, Boston; Willy Meyer, New York, and C. N. Dowd, New York.

Dr. Emil G. Beck, Chicago, read a paper on "Incorrect Technic as a Cause of Failure in the Application of Bismuth Paste in Chronic Suppurative Sinuses and Empyema." Discussed by Drs. A. J. Ochsner, Chicago, and Emil G. Beck, Chicago.

WEDNESDAY, JUNE 14—MORNING

Dr. C. A. Elsberg, New York, read a paper on "Some Technical Features of Spinal Surgery, with Report of Results in 150 Spinal Operations." Discussed by Drs. E. Sachs, St. Louis, and C. A. Elsberg, New York.

Dr. Arthur A. Law, Minneapolis, read a paper on "Surgery of the Brachial Plexus." Discussed by Drs. Dean D. Lewis, Chicago, and Arthur A. Law, Minneapolis.

Dr. Carl B. Davis, Chicago, read a paper on "Free Transplantation of the Omentum Subcutaneously and Within the

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Abdomen." Discussed by Drs. Alfred A. Strauss, Chicago; John Staige Davis, Baltimore, and A. T. Mann, Minneapolis.

Dr. J. Shelton Horsley, Richmond, Va., read a paper on "Operative Treatment for Threatened Gangrene of the Foot, with Special Reference to Reversal of the Circulation." Discussed by Drs. Dewitt Stetten, New York; Charles Goodman, New York; Nathaniel Ginsburg, Philadelphia; Carl Beck, Chicago; G. M. Dorrance, Philadelphia; E. Laplace, Philadelphia; J. F. Corbett, Minneapolis, and J. Shelton Horsley, Richmond, Va.

Dr. Charles C. Green, Houston, Texas, read a paper on "Stab Wounds of the Chest Involving the Diaphragm with Diaphragmatic Hernia." Discussed by Drs. J. E. Moore, Minneapolis, and Charles C. Green, Houston, Texas.

Wednesday, June 15—Afternoon

A joint meeting was held with the Section on Practice of Medicine.

The meeting was called to order by Dr. Roger S. Morris, Cincinnati.

The following papers were read as a symposium on the "Spleen."

Dr. George R. Minot, Boston, and Dr. Roger I. Lee, Boston: "The Immediate Effects of Splenectomy in Pernicious Anemia."

Dr. E. B. Krumbhaar, Philadelphia: "Late Results of Splenectomy in Pernicious Anemia."

Dr. Joseph L. Miller, Chicago: "Splenectomy in Chronic Anemia, Exclusive of Pernicious Anemia, and in Chronic Icterus."

Dr. Charles H. Peck, New York: "Splenectomy for Hemolytic Jaundice."

Dr. Donald C. Balfour, Rochester, Minn.: "Indications for Splenectomy in Pernicious Anemia and the Technic of the Operation."

Dr. Roy D. McClure, Baltimore: "Pernicious Anemia Treated by Splenectomy and Often-Repeated Blood Transfusions."

These six papers were discussed by Drs. Frank Smithies, Chicago; Beth Vincent, Boston; H. Z. Giffin, Rochester, Minn.; W. S. Thayer, Baltimore; G. A. Friedman, New York; S. J. Meltzer, New York; Walter V. Brem, Los Angeles; Roger I. Lee, Boston; Edward B. Krumbhaar, Philadelphia, and Joseph L. Miller, Chicago.

Thursday, June 15—Morning

The meeting was called to order at 9:15 by the vice chairman, Dr. Fred T. Murphy, St. Louis.

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The following officers were elected: chairman, Dr. W. D. Haggard, Nashville, Tenn.; vice chairman, Dr. A. A. Law, Minneapolis; secretary, Dr. E. H. Pool, New York; delegate, Dr. Dean D. Lewis, Chicago; alternate, Dr. John T. Bottomley, Boston.

Dr. Charles H. Mayo, Rochester, Minn., read a paper on "Removal of the Right Colon: Indications and Technic."

Dr. John T. Bottomley, Boston, read a paper on "Some Results of Colectomy and Exclusion of the Colon in Cases of Chronic Arthritis."

These two papers were discussed by Drs. Rea E. Smith, Los Angeles; W. R. MacAusland, Boston; J. M. Lynch, New York; J. E. Tuckerman, Cleveland; J. Shelton Horsley, Richmond, Va.; J. W. Draper, New York; Joseph E. Johnson, Memphis, Tenn., and Charles H. Mayo, Rochester, Minn.

Dr. Raymond P. A. Sullivan, Brooklyn, read a paper on "Perforating Ulcers of the Stomach and Duodenum." Discussed by Drs. Charles H. Peck, New York; J. T. Bottomley, Boston; H. D. Johnson, New York, and R. P. A. Sullivan, Brooklyn.

Dr. John Staige Davis, Baltimore, read a paper on "Plastic and Reconstructive Surgery." Discussed by Drs. Emery Marvel, Atlantic City, N. J., and J. S. Stone, Boston.

Dr. W. W. Grant, Denver, read a paper on "Sarcoma of Intra-Abdominal Testicle." Discussed by Drs. William B. Coley, New York, and W. W. Grant, Denver.

Dr. F. Gregory Connell, Oshkosh, Wis., read a paper on "Chronic Appendicitis." Discussed by Drs. J. A. Black, Pueblo, Colo.; E. Laplace, Philadelphia, and M. H. Fussell, Philadelphia.

THURSDAY, JUNE 15—AFTERNOON

The meeting was called to order at 2:15 by the chairman, Dr. E. Wyllys Andrews, Chicago.

Dr. Emmet Rixford, San Francisco, delivered the oration on surgery, entitled "Surgical Aspects of the Industrial Accident Insurance." No discussion.

Dr. Lincoln Davis, Boston, read a paper on "Complications and Sequelae of the Operation for Inguinal Hernia." Discussed by Drs. Henry O. Marcy, Boston; Daniel N. Eisendrath, Chicago; Edward W. Lee, New York, and Lincoln Davis, Boston.

Dr. R. L. Payne, Jr., Norfolk, Va., read a paper on "The Surgical Problem of Symptomless Hematuria: Its Causes and Surgical Relief." Discussed by Drs. H. A. Royster, Raleigh, N. C.; J. S. Horsley, Richmond, Va., and R. L. Payne, Jr., Norfolk, Va.

Dr. A. R. MacAusland, Boston, read a paper on "A Consideration of Fractures and Other Injuries of the Hip."

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Dr. John C. A. Gerster, New York, read a paper on "Nail Extension in Fractures of the Lower Extremity."

Dr. Arthur T. Mann, Minneapolis, read a paper on "Nails and Screws Through Joint Surfaces in Autografts and in Fractures Into Joints."

These three papers were discussed by Drs. Charles E. Thompson, Scranton, Pa.; R. H. Sayre, New York; F. H. Albee, New York; James T. Watkins, San Francisco; W. R. MacAusland, Boston; Charles A. Parker, Chicago; A. B. Fitch, Factoryville, Pa.; L. F. Schmauss, Alexandria, Ind., and A. T. Mann, Minneapolis.

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METHODS AND RESULTS IN GASTRIC SURGERY

GEORGE W. CRILE, M.D.
Fellow of the American College of Surgeons
CLEVELAND

The basis for this paper is a critical study of 472 operations on the stomach performed by my associates, Drs. Bunts and Lower, and myself, and in the records of Lakeside Hospital. Of these, 132 were performed by Dr. Lower and myself in accordance with the principle of anociation, these cases including explorations in cases of inoperable cancer, resections, and gastro-enterostomies for cancer and ulcer. Among these 132 cases there have been three deaths, a reduction from the former mortality rate in like cases of not less than 3:1. In but one other field is anociation so strikingly beneficial — in the surgical treatment of exophthalmic goiter.

Originating in the great school of Vienna, fostered in Germany, its progress accelerated by Mayo-Robson, given a classic status by Moynihan, mechanized by Murphy, and culminating in the Mayo Clinic, the great field of gastric surgery through trial and error, progress and extension has become established; yet in bad risks the mortality is still too high.

That the high mortality rate of gastric operations has been due not to faults in operative technic but to some unappreciated underlying factor is evidenced by the always comparatively low mortality rate of operations on the pelvic organs. Why have the excisions of large pelvic tumors, for example, always caused fewer deaths than major operations on the stomach or on the intestines? It is because the functions of the stomach and intestines govern so completely the balance of material for constructive metabolism.

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This fact not only gives us the key to the fundamental cause of the high hazard in major gastric operations, but also suggests a plan of attack by means of which the mortality of these operations may approach the low mortality of pelvic surgery.

Whether the case be a resection for cancer or a gastro-enterostomy for ulcer, the reserves of the starved patient must be built up by the introduction of water, sodium bicarbonate and glucose and especially by an adequate amount of sleep and rest; and acid formation must be diminished by the elimination, as far as possible, of worry, fear, anxiety, exertion, loss of sleep, trauma and anesthesia.

In the case of ulcer, the fate of the ulcer-bearing area is the chief consideration, for the evidence on many sides, especially that presented by the Mayo Clinic, shows the tendency to cancer growth in ulcers of the stomach, though happily not in duodenal ulcers. Our lamented President, Dr. Rodman, made a logical departure in the complete excision of the ulcer-bearing area, but even this is not enough. At this point we must join hands with our medical confrères and for a period of many months — six or more — the patient should be kept under strict dietetic care, such, for example, as the Sippy regimen. If the patient is dismissed from the surgeon's care to the same habits of life, and the same dietetic carelessness that existed when the ulcer originated, and if in certain cases mouth infections and teeth defects are uncorrected, then there is bound to result a certain percentage of failures. It is just as illogical to exercise no care over a postoperative ulcer patient as it would be to dismiss a postoperative exophthalmic goiter patient without therapeutic instructions and prolonged oversight.

After surgical treatment for ulcer, as after a thyroidectomy, the immediate relief is so marked that it is difficult to make the patient believe in the necessity for special care during a long period.

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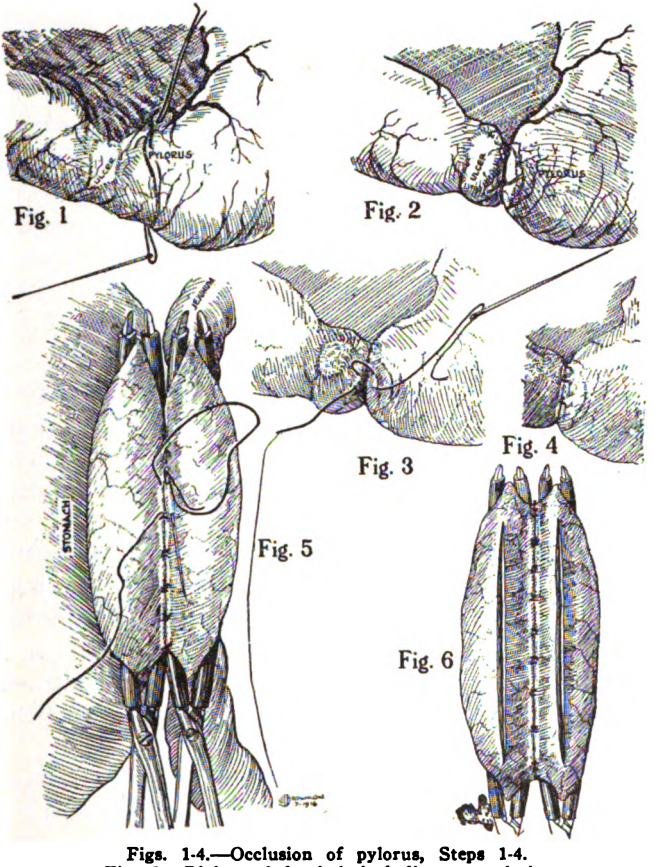
The clinical results of the surgical treatment of duodenal ulcers are even more striking than in cases of gastric ulcer. The rapid disappearance of gastric ulcer masses is illustrated by cases reported by



Figs. 1-4.—Occlusion of pylorus, Steps 1-4.
Fig. 5.—Right-angled stitch including muscularis.
Fig. 6.—Incisions in stomach and jejunum.

Lilienthal and Willy Meyer in which ulcer masses supposed to be carcinoma have disappeared within a week or more after gastro-enterostomy, as proved at the second phase of a two stage operation. I myself have seen three such surprising results.

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TECHNIC

As has already been stated, the principle of anociation is applied throughout the operation — minimum handling; feather edge dissection; avoidance of pulling and tearing manipulations; the injection of novocain before the division of skin, fascia, muscle and peritoneum; and a massive infiltration with quinin and urea hydrochlorid, at a distance from the line of incision, immediately after the abdomen is opened.

Shall the pylorus be occluded? By what technic? In the light of our experience occlusion of the pylorus is rarely required, as the relief without is about equal to that secured with occlusion. When the pylorus is occluded, a simple method, such as a circular tying with a suture reinforced by interrupted stitches of silk answers well.

The Jejunal Loop.—The most important mechanical problems are the length of the jejunal loop and its direction. The length should be most carefully considered. If the loop is too short there will be intermittent interference with the desired current of the jejunal content which at times will accumulate in the stomach. If the loop is too long a vicious circle may become established. The correct position and the length is that which equalizes the pull on the supports of the stomach and the jejunum. This adjustment can only be secured empirically and cannot well be described.

Shall the loop run from right to left or vice versa? The direction should be that which mechanically is the more comfortable. If the stoma is placed near the pylorus, then usually the loop runs from left to right; if the stoma is well toward the left, then the loop runs from right to left.

The Stoma.—The work of Cannon and Blake and of others shows that food propulsion is under functional control rather than the control of gravity. Therefore a stoma near the pylorus is sanctioned for

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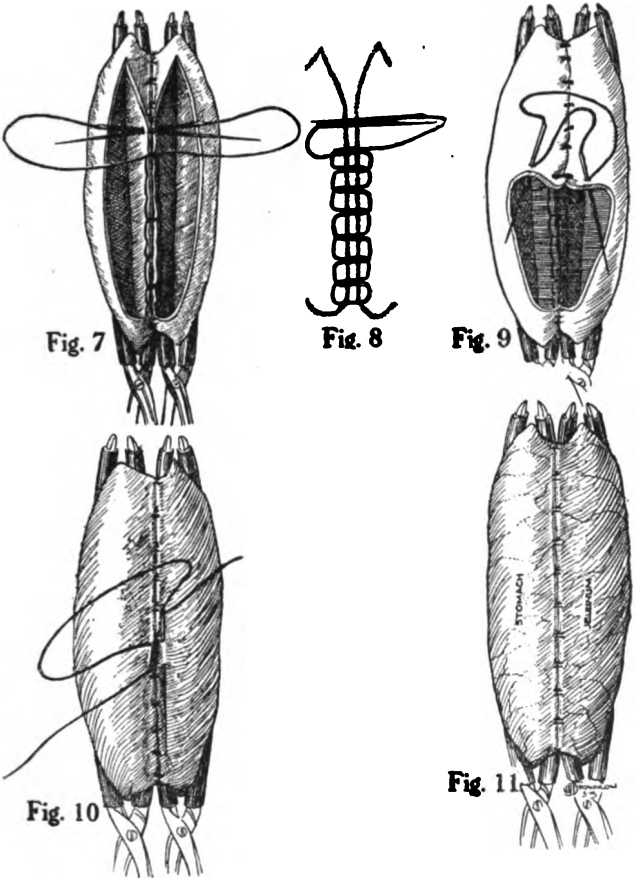
physiologic as well as practical reasons; a stoma far from the pylorus may cause serious stasis. Since the stoma exerts no control over the propulsion of food in either the stomach or the duodenum, its direction,



Figs. 7-9.—The cobbler stitch.
Figs. 10-11.—Interrupted right-angled stitch over cobbler stitch.

whether oblique, transverse or longitudinal, is unimportant. The stoma tends in time to become oval or round with a sharp margin. Even a large stoma does not materially interfere with the retention of stomach

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contents during the early hours of digestion; and a very small stoma, like a very small pylorus, may allow enough food to pass through.

In two outside cases I enlarged a stenosed stoma, but in none of my own cases has the stoma shown an impairing contraction, whether the pylorus was closed or open, apparently making no difference.

The Incision Through the Mesocolon.— Owing to its extreme elasticity, it matters little whether the incision through the mesocolon in a posterior gastro-enterostomy be vertical, horizontal or oblique; but it

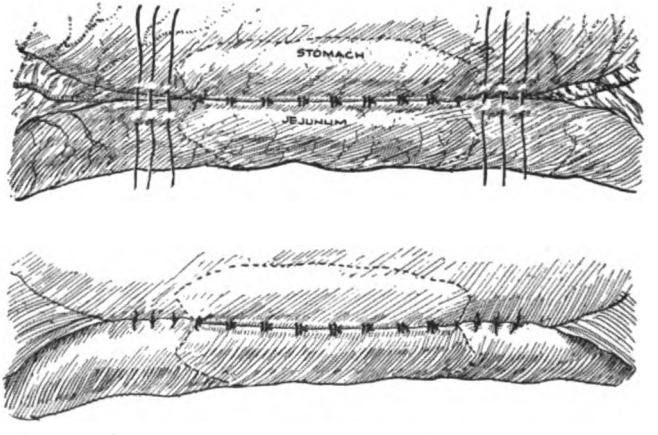

Fig. 12.—Stay sutures inserted at each end of completed anastomosis: above, untied; below, tied.

should not divide large arteries. The incision may be enlarged in several directions, but always by division with a sharp knife, and not by tearing.

The Suture.—The suture must prevent bleeding and leakage and must maintain absolute coaptation of the serosa. For securing these ends the cobbler stitch inserted with Bartlett needles is ideal. Mayo has pointed out a serious objection to the use of silk for the inner suture — it may remain indefinitely and cause ulcers. We have found it the best procedure to use chromic catgut for the first row of sutures, these

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being reinforced by interrupted right-angled silk sutures including the muscularis. In no case has there been serious hemorrhage.

The Jejunal Angles and the Opening in the Mesocolon.— Unless guarded against, acute angulation of the jejunum at its junction with the stoma may occur. This may be prevented by the insertion of several silk sutures to hold the afferent and the efferent loops closely against the stomach. A more serious occurrence is a mass herniation of the small intestine through the opening in the mesocolon. This in turn is prevented by suturing the margin of the mesocolon opening to the stomach approximately an inch above the margin of the stoma.

This procedure also gives freedom to the stoma and the jejunal loop.

SUMMARY

In starved cases of gastric cancer or ulcer the reserve alkalinity of the body has been reduced. Nutrition is impaired, the reserve stores of water and of potential energy are diminished. Surgical treatment, therefore, includes the preoperative and postoperative introduction of water, of alkalies and of glucose in large quantities; the management of the patient by interns and nurses in such a manner as to avoid such acid forming activations as anxiety, loss of sleep and exertion; the application of the principle of anociation throughout the operation itself, and in cases of ulcer, a prolonged postoperative period — six months at least — under therapeutic direction, especially as regards diet.

ABSTRACT OF DISCUSSION

Dr. Albert J. Ochsner, Chicago: With the ordinary stomach operation with the patient in a fairly good condition there should be no mortality. But in this class of cases there is a considerable number of individuals who have lost this reasonable amount of margin of safety and here we find the mortality. The other cases in this class have no mortality and surgical judgment is the element that reduces the mor-

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tality. There are certain things that can be avoided which if not will narrow this margin of safety to a dangerous degree. If the traumatism and the strain on the nervous system are reduced to the very slightest amount then you have removed the portion that is lacking in these patients and you place these particular patients that give the mortality ordinarily in the same favorable class with the rest. Dr. Crile's way of excluding the pylorus seems very attractive. I think that it will be necessary, however, to place the sutures rather more deeply than most surgeons would be inclined to place them because if they are not placed more deeply the communication will be reestablished afterward, and judging from the illustrations shown the sutures were evidently placed more deeply than they are ordinarily placed. I wish to direct attention to another point in which he also increases the margin of safety, namely, in the careful suturing of the wound between the intestine and the stomach so that there cannot possibly be any loss of blood after operation because a little loss of blood in this class of cases is of the greatest importance.

Dr. R. C. Coffey, Portland, Ore.: Dr. Crile has failed to emphasize sufficiently one of the principal reasons for his splendid results, namely, that he uses two stages or sittings when he is doing an excision operation.

In our experience the adoption of the two-stage operation has been the most important single step we have taken in abdominal surgery of any kind for some time. In excising portions of the pylorus our mortality has certainly been decreased at least two or three times when compared with results in similar cases done at a single sitting. We have not had a single fatality from the second stage of the operation for four years. The mortality we have had in gastric surgery has been confined to the primary gastro-enterostomy. In other words, the two-stage operation reduces the mortality in an excision to practically the same as a simple gastro-enterostomy. I would like to ask Dr. Crile to explain his view of the cause of the improved results following the two-stage operation. Is the first operation intrinsically more serious, or does it produce a sort of immunity for the second operation? The question as to the cause of secondary ulcer has not been settled. Dr. Mayo believes it is due practically always to the linen or silk suture. We have not been entirely convinced. We have had four ulcers of this type. It is true we have found linen suture at the base of the ulcer in three instances, but the ulcers have extended 2 to 3 inches away from the suture and in one case in which we used catgut entirely we had an ulcer of the same kind. Curiously enough the four ulcers occurred in two patients. In each case the ulcer recurred and in one of these cases at least it recurred after the second removal that we know of in spite of the fact that catgut was used throughout. There is a point we learned

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in experimental surgery. An interrupted silk or linen suture that penetrates all the coats of the stomach and intestine is eliminated in a few days into the lumen. A suture that does not penetrate the deep tissues remains encysted. A continuous suture which penetrates the lumen at some points and is only peritoneal at other points can neither eliminate itself into the lumen nor can it become encysted. It is in this class that we have found the suture still hanging in the wound. This is undoubtedly the type of suture that is frequently found in these cases of secondary or recurring gastro-jejunal ulcer and may be simply an innocent bystander.

Dr. Henry O. Marcy, Boston: Twenty-five years ago I demonstrated that buried absorbable sutures should be used in operations of this type and slowly came to the conclusion on experimental evidence that catgut was defective and kangaroo tendon sutures were greatly to be preferred. They were prepared in a careful way by chromicizing and thus made durable. Again, the way in which they were applied. Dr. Coffey said that it is unwise to penetrate all the coats of the intestine. Of course, since the intestinal contents are infective one must be sure to have the strong connective tissue layer of the intestine included. For over twenty-five years I have used the continued double tendon suture, the so-called cobbler stitch. I use a needle with an eye near the point. It is rethreaded with the opposite end and thus carries the suture through one and the same opening. The superficial layer of sutures is carried through the external coat only but must itself be buried. In other words, it is absolutely buried. In this way, as Dr. Crile has emphasized, one damages the parts a great deal less than in any other and saves the lesions that are so likely to occur, to make adhesions and give subsequent trouble.

Dr. John B. Deaver, Philadelphia: As to anociassociation, I will say little as I know practically nothing about it, but from the fact that it is recommended by Dr. Crile we must take it that it is valuable. I would take exception to what Dr. Crile says in reference to pyloric occlusion. This is only a makeshift. It is not permanent. I have operated in cases the second time that I had originally operated myself and I know that with few exceptions pyloric occlusion is not particularly satisfactory. When the pylorus is tied off tightly the tissues are devitalized and as a result we have ulceration, separation and restoration of the lumen. I strongly emphasize cutting out the ulcer when it is possible; this is my practice. In the last forty cases I have done at the German Hospital, among which were many pylorectomies, there was no fatality. The majority of ulcers of the duodenum are situated in the first portion anteriorly; and when the induration is not too pronounced the ulcer can be excised; when induration is considerable amputation of the duodenum and posterior gastro-enterostomy, in other words pylorectomy,

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are indicated. Where the ulcer involves the lower portion of the first part of the duodenum coming in close proximity to the head of the pancreas it is my practice to dissect the duodenum away from the pancreas, purse-string it, invaginate and so forth. Where induration is extensive and where it is impossible to purse-string, I oversew the duodenum and sew the stump into the head of the pancreas. As to the subsequent course of these cases I am prepared to say that they go along nicely if they are not medicated. A small number are nauseated; some vomit, which is relieved usually by one lavage or by lavage repeated two or three times. Lavage is of most importance in the after-treatment of these cases.

Dr. Alfred A. Strauss, Chicago: Dr. Crile has advanced the technic of gastro-enterostomy, but I do not believe that he has advanced the work on pyloric closure when he uses a silk ligature method, which is only a temporary closure for a chronic indurated ulcer. Ulcer of the pylorus and duodenum is primarily a medical disease, and careful medical treatment will heal many of these ulcers. When the ulcer has become chronic and indurated, surgical interference is indicated. I do not believe that a temporary closure with a silk ligature, which does not hold the pylorus closed any longer than from ten to thirty days, is of any value in a chronic ulcer of the pylorus or duodenum, which takes weeks and months to heal. I have recently fluoroscoped a number of such cases in which the pylorus was closed over by a silk ligature the size of an umbilical tape. In one case the pylorus was opened and the bismuth meal passed through at the end of ten days, in another case at the end of eighteen days, and practically all of them were open at the end of twenty-one days. In addition, two of these cases had almost fatal hemorrhages. What value has such a temporary closure on a chronic indurated ulcer? We know from fluoroscopic and Roentgen ray work that from 40 to 50 per cent. of the food passes through the pylorus, no matter how well the gastro-enterostomy has been performed and placed. Therefore, the irritation to the ulcer surely cannot be lessened sufficiently to produce healing. The only way in which gastro-enterostomy alone helps is from the fact that the bile secretions regurgitate through the opening into the stomach and alkalinize the secretions. This surely cannot be constant, for if 50 per cent. of the food passes through the pylorus anyway, this food as it passes over the duodenum neutralizes the bile. So the only time bile can flow in any quantity through the gastro-enterostomy is when the stomach is empty or no food is passing over the pylorus. Therefore, if a pyloric closure is indicated at all, a permanent closure is indicated, such as von Eiselsberg's unilateral exclusion, or the simple submucous fascial transplant method which I devised. This fascial transplant closure has been shown to

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be absolutely permanent, and certainly is not an additional risk to the patient. There is no chance of hemorrhage or infection. I have so far seen no case of leakage following this procedure.

Dr. G. W. Crile, Cleveland: The discussion has focussed largely on a procedure we rarely do — namely, the occlusion of the pylorus. We have found out from experience that without any occlusion of the pylorus the symptoms disappear, and the jejunal lesion heals promptly. I am inclined to agree with Paterson that in all gastro-jejunostomies a certain amount of alkaline fluid comes through the new stoma into the stomach and reduces the acidity; this probably is as much a curative factor as any other feature of the procedure. Dr. Coffey raised a very interesting point. I think the reason the first contact with the very bad risk patient is so menacing is because of the narrow margin of safety due to starvation. Dr. Deaver's more radical views show that in a large measure each surgeon must be his own monitor. In these starved cases we must sometimes resort to the technic of Von Eiselsberg, viz.: at first merely bring up the jejunum under local anesthesia and feed through a tube in order that the reserves of the patient may be increased. In this short paper it has been impossible to explain the reasons for many of the steps suggested. Our purpose has been rather to sum up in a very practical way the present status of gastric surgery in the Lakeside Clinic.

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SOME OBSERVATIONS ON THE TEACHING OF SURGERY

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Every teacher recognizes the fact that success in the making of a surgeon depends, first of all, on the aptness of the pupil. It may be true that "poets are born, not made," but years of patient toil in training await the making of a surgeon. He must possess by nature those rare qualities which are essential to successful development. His must be a brain not only endowed with an extraordinary power of analysis, but equally gifted in construction. He must possess moral courage of that heroic type which recognizes in "duty" the sublimest word in our language, and physical courage which is not embarrassed by obstacles seemingly insurmountable, nor appalled, even in the presence of the Great Disaster.

In the performance of a formidable operation, the surgeon stands in need of qualifications greater than those of the successful general, for while each must be quick to appreciate the kaleidoscopic changes in their respective fields, the commander relies on others for the execution of his orders: the *hands* of the surgeon alone must meet the issue before him.

May I emphasize the plural of these essential members, the hands? For of all the world's workers, the surgeon needs two hands, instead of one.

Of the various problems in the development of our race to its fullest usefulness, the failure to appreciate the value of ambidexterity is to me the most inexplicable. Bimanual deftness developed in the forming,

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the growing period, not only adds to technical perfection, but beyond all doubt aids in the development of both halves of the brain, so that these two halves, equally well nourished and alert, work together as one organ, if I may employ a homely simile, like the two horses of a well trained and well matched team, thus assuring the complement of mental energy.

Physically, mentally and morally qualified, the embryo surgeon enters the laboratory, for on this foundation must rest the hope of efficiency. Only a thorough knowledge of the normal tissues can render possible the recognition of the many morbid changes which are characterized as disease. By the laboratory is implied not only microscopy and organic chemistry, but also normal and abnormal or morbid anatomy, and animal experimentation. In the mastery of regional anatomy, the employment of frozen sections is essential; and while the perfection of modern photography enables the student to preserve accurate pictures of the sections, nothing serves to fix the relations of the tissues in the mind so well as hand tracings on frosted glass, laid directly on the section.

While in the teaching of clinical surgery, some general idea of the technic may be obtained by observation, from points more or less removed, in the ordinary amphitheater, the practical knowledge which is absolutely essential can be acquired only by immediate personal contact. The hospital intern reaps invaluable benefit from his position as assistant at the elbow, or across the table, from the master; and if he be wise, and the teacher foresighted, he will be made to follow each case throughout the postoperative period, even to the necropsy, where the bitter lesson of error in diagnosis or technic may often be profitably emphasized.

Year by year, in our work at the polyclinic, we have approached what we now call the "group method of personal instruction," allotting the rôle of intern or assistant intern to the student who, after the required

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preliminary term of service, having demonstrated, in our judgment, a justifiable fitness, is allowed to operate under immediate supervision and guidance.

With the advent of motion picture photography, we began, and are still carrying on, experimentation, in order to satisfy ourselves of the value of this means of demonstrating operative technic to our classes. Operations on the cadaver and the living subject have proved fairly satisfactory, and we incline strongly to the opinion that, with an improved apparatus and wider experience on our own part, as well as on the part of the mechanician, still better and even more satisfactory results may be achieved.

A gratifying feature of this particular work is that it makes it possible to lend these films to medical societies in all parts of the country, thus enabling many practitioners who cannot find time to visit the central clinics to profit by these attractive demonstrations.

ABSTRACT OF DISCUSSION

Dr. Arthur Dean Bevan, Chicago: I am not sure whether these moving pictures will have any great value in the teaching of surgery or not. They have a certain value, but I do not think they in any way replace the actual work on living material itself. In the discussion of the teaching of surgery we must differentiate between two very definite and distinct things, the teaching of surgery in the medical school to men who are being prepared to become general practitioners, and the teaching of surgery to men who are to become surgical specialists in various fields. I shall not go into the details of the teaching of undergraduate surgery. I would like to emphasize the point, however, that it must be very largely done with actual material in the hospital and dispensary and a part of that teaching, even for the man who is to become a general practitioner, must be at least a year in a hospital as an intern. Most of us received our surgical training either in a medical school alone or in a medical school with the addition of a hospital internship, and there was a time when men who had this hospital year were regarded by those who had not as being fortunate and as having had a great advantage. Today there is a demand for a better type of surgeon than the man who starts in simply at the end of his college work in medicine or even with a hospital internship. I believe that the time has come when the members of the organized American profession should recognize the fact

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that in order to be a skilled specialist in any surgical field that there is required more than the mere training in the college and the hospital internship. It is our duty to provide some scheme for additional special training of at least two or three years of work in our best clinics, in our best surgical departments, in our best hospitals. We must provide some means by which these young men who come to us anxious to specialize in some surgical field will be able to receive the necessary additional instruction, i. e., two or three years of work in a surgical clinic as an assistant in some well organized clinic. To do this we must do another thing. Many men who go into medicine have very little money. They cannot afford to spend two or three years to prepare themselves for special work in surgery. For these men we must provide salaried surgical fellowships, salaried house surgeonships. They are sometimes the very best men that come to us.

Dr. Thomas A. Stoddard, Pueblo, Colo.: We are told many of the things that a medical student must have to perfect himself in surgery. But not all of the things have been mentioned. He must have teachers. That is very important. Neither the profession of medicine nor any other is blessed with many giant intellects in the line of teaching. And when we take into consideration the fact that many of our teachers are chosen because they have a "political pull," if I may use that expression, and not because of any fitness on their part to convey ideas to the students, then we must realize that it is a most important question that we have before us. The ability to teach does not come by education. It is intuitive. Not many, in the aggregate, are able to convey to others the ideas that they possess. Not only must we be able to convey to students' minds the proper methods of operative procedure, when it comes to surgery, but more important, when to operate, and most important of all, when not to operate. The honor of the profession is forgotten too frequently in our rush for new operative procedures, and we must teach our students that there is something more necessary than the ability to cut tissue, to tie a vessel.

Dr. Henry O. Marcy, Boston: Years ago Marion Sims was in the forefront as one of the great surgical pioneers. John A. Wyeth married his beautiful daughter and you can see where Marion Sim's work has fructified in that which was shown you this very day. Our beloved Dr. Wyeth found his inspiration and his encouragement in the greatest of home influences. A large circle of devoted friends mourn the recent death of this most noble woman, Florence Nightingale Sims.

Star of the North; thou most constant star,
  Wherever I wander o'er the land or sea;
Beacon of hope, still shining from afar,
  Unto the heaven of rest thou guidest me.

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Dr. John A. Wyeth, New York: I agree fully with Dr. Bevan, that moving picture demonstrations of operations can never take the place of that better method of teaching surgery, the "group method" and the "intern method." That the moving pictures will find a large field, I have no doubt, especially in demonstration of the grosser technic of certain surgical procedures to larger audiences than can be benefited by the group method. We still use the amphitheater method with great satisfaction to our students, but we are employing more and more each year that method which allows not more than four or five of our students to be present around the operating table at any one procedure, and, as a rule, some of these are being trained as assistants. We are now going further than this with what we have termed our "assistant intern method." With the very large material at our command, and a large staff, we are enabled to assign a pupil who takes a course of study for six months to one year, or longer, to two operators, to each of whom he serves as second assistant half of his term, and as first assistant for the remainder, during which later period, if he has demonstrated ability to operate within perfect limits of safety to the patient, he is allowed the same privileges that are granted to interns on the hospital staff in the last months of their service. This method we find has given us more satisfaction as teachers than any other.

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NITROUS OXID-OXYGEN ANESTHESIA IN MAJOR SURGERY

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To avoid misunderstanding, let me state at the outset that this paper is written from the point of view of the operator, not the anesthetist. No claim is made to special knowledge concerning the theory and technic of general anesthesia or the abstract merits of the several anesthetic agents, and no academic discussion along these lines will be attempted. My sole purpose is to present conclusions based on personal experience in operating under nitrous oxid-oxygen anesthesia, and to indicate some of the practical advantages it has seemed to afford in the field of major surgery.

It is fair to say at this point that no opinion as to the comparative value of anesthetics and methods of anesthesia is entitled to weight unless it is founded on the actual clinical experience of a competent and strictly impartial observer. Mere impressions are apt to be misleading; conjecture with reference to any scientific problem is always worse than useless. Desire to know the truth is the first essential. This established, the conditions of the investigation are quite certain to be safeguarded, and the final verdict to be a just one.

During the past three years I have performed approximately 300 major operations under nitrous oxid-oxygen anesthesia. Without stopping to enumerate them in detail, I may say that the list includes thyroidectomy, prostatectomy, the several procedures requiring preliminary dilatation of the sphincter ani, and excision of the rectum, as well as the various operations on the abdominal and pelvic viscera. In

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the great majority of these cases (certainly not less than 90 per cent.) not a drop of any other general anesthetic was used, though in practically all cases I employed local anesthesia in addition. I approve and advocate the addition of ether when it is indicated, in amount sufficient to secure the result desired; but from clinical observation I am of the opinion that, where this is necessary, it is because of some fault in the preparation of the patient, or, more rarely, due to some extraordinary complication of the operation itself. In such cases the amount of ether required is usually very small, not exceeding 1 or 2 drams as a rule, and a second occasion for its use rarely arises in the same operation.

In this connection it should be emphasized that local anesthesia is a most valuable adjunct to the successful employment of gas anesthesia. This is particularly true in abdominal cases in which muscular relaxation must be had to avoid undue traumatism. Here the result desired is readily accomplished by carefully infiltrating the nerve-bearing tissue of the abdominal wall with a weak solution of novocain (1:400) or cocain (1:1,000). The degree of relaxation secured is a true index to the thoroughness of the local infiltration.

The operative time in the 300 cases referred to varied from thirty minutes to two hours, averaging probably about one hour. I have not found it necessary in any case to suspend the work because the anesthetic was not well borne. In fact, as my confidence in the gas-oxygen method and in my anesthetist has increased, I have come to look with less and less anxiety on cases that heretofore seemed most formidable, and to find myself willing to offer the aid of surgery to patients whom I should formerly have advised against operation.

In the entire series there was no fatality in any way chargeable to the anesthetic. Further, there was not an instance in which danger from this source even

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threatened a patient. Dr. R. F. Hastreiter, who has administered the gas most often for me, tells me that he has now administered it for surgical anesthesia more than 500 times without a fatality and without unfavorable symptoms in a single case.

DISADVANTAGES

There are certain inherent difficulties and disadvantages in the use of nitrous oxid. The first and most important of these is the difficulty of finding anesthetists skilled in its administration. The prevalent idea that anybody, including student and nurse, can give the anesthetic emphatically does not apply to this agent. On the contrary, rare judgment and much experience are required for its safe and successful employment. Happily this difficulty is not insuperable, since competent men are taking up the work in every community as the demand for gas anesthesia increases.

Another disadvantage is the more or less cumbersome character of the apparatus required. The ingenuity of the manufacturers has done much to overcome this difficulty, simplified outfits, both hospital and portable, being now provided which, if given proper care, are quite satisfactory. Where one is so fortunate as to be able to concentrate all his work in a single perfectly equipped hospital, this disadvantage is readily eliminated.

A third disadvantage is the relatively high cost of the gas. This has been greatly reduced by the improved methods of manufacture and handling, and to an equal or greater extent by improved methods of administration. Strictly speaking, the matter of cost does not enter into the question. The real consideration concerns only the best interests of the patient.

One other difficulty should be mentioned, namely, that of securing nitrous oxid entirely free from inpurities. When nitrous oxid first came into use as a general anesthetic, it was thought that a certain amount of cyanosis was necessary and inevitable in every case.

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We now understand that this condition is to be regarded as a danger signal, due for the most part to poisonous impurities in the gas, though it is, of course, true that the same effect may be produced by the unskilled anesthetist with gas of the purest quality. The valuable paper of Warner,[1] describing the experience of Lakeside Hospital, clearly establishes the facts that it is perfectly practicable to produce pure gas, and that with the impurities the dangers of this agent as an anesthetic virtually disappear. His observation that entire freedom from cyanosis may be maintained, while the patient is otherwise presenting symptoms of asphyxia, is deserving of special note.

LIMITATIONS

The applicability of nitrous oxid as an anesthetic embraces the entire field of surgery, so far as my experience goes, wth a single exception. It is not satisfactory in major operations on the mouth, nose and air passages. To maintain surgical anesthesia with this agent requires the complete exclusion of atmospheric air, and the effect is so evanescent that the mask cannot be removed even momentarily without the patient's arousing. Breathing tubes have been devised to overcome this difficulty, but with only partial success. In such cases the anesthesia may be induced by the gas and ether substituted before the operation proper is begun, the patient thus escaping the primary stage of irritation and excitement. With this exception I know of no limitations in the practical application of this method of anesthesia.

ADVANTAGES

The advantages of nitrous oxid are numerous and may well be considered under two heads: first, those which concern the patient, and second, those which concern more particularly the operator and the hospital.

1. Warner, A. R.: Manufacture and Administration of Nitrous Oxid for Anesthesia, The Journal A. M. A., Dec. 4, 1915, p. 1973.

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The two most important considerations from the standpoint of the patient are, of course, safety and comfort. Given a pure gas and a competent anesthetist, I am fully convinced that nitrous oxid is at least equally as safe as ether and, when the possibility of postoperative complications attributable to the anesthetic is included, more so. No one will gainsay that no such marked depression is observed following the former as the latter. In explanation of this fact we have only to remember that ether lowers the blood pressure while nitrous oxid raises it; that free perspiration and the consequent dissipation of the body heat is the rule under ether, while such a phenomenon is rarely observed under nitrous oxid; that the effects of ether are persistent, lasting usually for twenty-four hours or longer, while the effects of nitrous oxid are by comparison decidedly transient. We further know that ether is one of the best of all lipoid solvents and that, being so diffusible, it permeates practically every fat-bearing tissue of the body, necessitating increased elimination at a time when the patient's organs are least able to respond. Postoperative pneumonia and suppression of urine following ether anesthesia are by no means rare. It will probably never be definitely known just how often the lighting up of a latent tuberculous process or the inception of an ultimately fatal nephritis may be due to the same cause.

Many factors contribute to the comfort of the patient under nitrous oxid-oxygen anesthesia. Any fair-minded observer who will study and contrast the condition of the patient before, during and after the operation in two similar cases, or series of cases, in which gas and ether respectively are administered by equally competent anesthetists, cannot fail to be impressed with the comparative merits of the former in this regard. The disagreeable effects of ether anesthesia are common knowledge, and inspire no small part of the dread with which surgery is contemplated. With the proper assurance in advance, the patient

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approaches nitrous oxid anesthesia in a much more tranquil frame of mind — unquestionably a distinct gain. Nitrous oxid is nonodorous, nonirritating, and produces unconsciousness with the first few inhalations. No sensation of strangling, no talking or struggling, no nausea result. When the flow of gas is stopped, full consciousness is regained in a very few moments, and nausea and vomiting are chiefly notable for their rarity of occurrence. In the exceptional case in which emesis is seen, it is more in the nature of a simple regurgitation, usually occurs only once, and is not accompanied by the deathly nausea and depression which result so commonly from ether. With respect to the several bodily functions, the normal is regained with striking rapidity. This is a matter of hours, not days, and convalescence from the operation, not from the operation plus the anesthesia, is much more promptly established, of shorter duration, and more comfortable in every way.

The gentleness of manipulation required, in operating under nitrous oxid, I regard as one of its most pronounced advantages. The anesthesia produced by this agent is never so deep and deathlike as that of ether. To operate successfully under nitrous oxid demands a studied respect for all tissues at every stage. By this means unnecessary traumatism is avoided, the amount of postoperative wound repair lessened, and the vitality of the patient conserved. The surgeon who regards the spectacular and his time record of supreme importance cannot hope to find this method of anesthesia entirely satisfactory.

I am convinced that nitrous oxid very appreciably broadens the field of surgery in that it makes it possible to extend its benefits to certain cases and conditions in which the administration of ether would involve too great danger. It is no small thing to be able to assure a weakened and suffering patient that he may have the chance of relief to which he is entitled without assuming undue risk from the anes-

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thetic itself. Several times within my own experience, patients have been successfully operated on when, with ether as the dependence, I should have approached the cases with the utmost reluctance and apprehension, if, indeed, I could have persuaded myself to undertake them at all.

From the standpoint of the operator and the hospital there are several additional advantages in nitrous oxid anesthesia which, while of secondary importance, to be sure, are yet worthy of being mentioned. There is a considerable saving of time in the operating room because of the rapidity with which the gas acts and because, when the operation is over, the patient, conscious and quiet, may be returned to his bed without the usual delay. The few minutes thus saved in handling a single case might easily swell into an hour or more in the course of a busy day — an item of no little moment both to surgeon and operating-room force.

A further very decided advantage to the hospital develops in the postoperative care of gas patients. The time of every hospital employee has a definite money value. After ether anesthesia the more or less constant attention of a nurse is usually required for a period varying from a few hours to twenty-four hours or more, depending on the amount of depression and the persistence of nausea and vomiting. This costs money. The use of gas does away with the need for so-called recovery rooms, the patient, conscious and comfortable, being returned directly to his own bed in a ward or room. Thus the disturbance of other inmates is minimized and the natural apprehension of other patients approaching the ordeal of operation allayed, instead of increased.

CONCLUSION

There is no topic before the profession today commanding greater interest than that of anesthesia, and rightly so, for it is universally recognized that further

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progress in surgery is dependent in no small degree on advances along this line.

The ideal anesthetic for major surgery is the one capable of producing analgesia and unconsciousness without danger or discomfort to the patient. Any agent or method which furthers this ideal — which tends in any way to relieve surgery of its harshness, and to smooth down the rough places on a road to health that patients justly regard as both formidable and forbidding, should receive our most earnest and open-minded attention. My experience with nitrous oxid as an anesthetic would seem to warrant the conclusion that it is entitled to high rank in this beneficent class.

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ABSTRACT OF DISCUSSION

Dr. W. I. Terry, San Francisco: I am in full accord with Dr. Cooke's conclusions as to the use of nitrous oxid and oxygen in major surgery. I have used this method consistently for the past four years in about 1,200 major cases and I am convinced that from the standpoint of the patient himself it is the best and safest anesthetic we have, when supplemented by local anesthesia. The absence of odor, the rapidity of action, the minimized after-effects are all for the comfort of the patient. The absence of heart, kidney, liver, blood and lung conditions postoperatively are the factors of safety which do not apply to the same degree with other general anesthetics. It seems to me that there are two principal reasons why the method has not had a very extended use. First, the lack of thoroughly trained anesthetists, and second, the increased cost. Both these factors will prevail against it until they can be modified and ether will still remain the method of choice where nitrous oxid and oxygen are not obtainable under the right conditions. Another objection that has frequently been made is the lack of muscular relaxation, particularly in abdominal work. This, to me, is simply a matter of technic in the use of the local anesthetic. When the local anesthetic is employed properly muscular relaxation is obtained, provided always that the nitrous oxid is given properly and the patient is kept in the right condition. With alcoholics, however, and some athletes, it is often necessary to give a little ether in addition, but in a minimum amount. The total is very small, indeed, in these cases. Another objection is that more time must be taken to do these operations, but time should not be measured against safety.

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Dr. Charles K. Teter, Cleveland: Nitrous oxid oxygen in general surgery has been in practically constant use in at least two Cleveland hospitals for over ten years. Cleveland was, I think, the first city where a nitrous oxid plant for the manufacture of nitrous oxid was installed in a hospital. The plant was installed first in St. Luke's Hospital about nine years ago and a little over one year afterward another plant was established in Lakeside Hospital. These plants, with modifications, have been in use ever since. Constant use of nitrous oxid in major surgery has proved to us that this anesthetic has its limitations, and I do not think that we have been led so far in our enthusiasm as to claim that it is the anesthetic of choice in every case. In most cases of minor surgery nitrous oxid and oxygen will give sufficient depth of anesthesia so as not to interfere with the accomplishment of the operation. The physical properties of nitrous oxid are such that it must be given at least 80 to 95 per cent. pure in order to bring about surgical anesthesia. No oxygen is liberated during its sojourn in the organism. Therefore it is an asphyxiant as well as an anesthetic, so that when you withhold less than the normal amount of oxygen in atmospheric air you have a certain degree of interference with normal oxidation, and if you give as high as 20 per cent. of oxygen you will not have surgical anesthesia, as we understand it. You will have perfect unconsciousness but not relaxation of the musculature. Then it becomes necessary to add something to nitrous oxid. Our method is to use preanesthetic narcotics, as morphin, ⅓ to ¼ grain, atropin, 1/150 to 1/100 grain; then if relaxation cannot be had, a sufficient amount of ether vapor is added to the mixture. Some object and say, "If you must add ether what is the use of giving nitrous oxid at all?" I claim that if you can withhold even 2 ounces of ether in a major operation you have done a great favor to that patient. In most of the apparatus on the market you will find ether attachments and some of you have probably noticed that there is a considerable amount of ether used during an hour's anesthesia. For instance, there may be 4 ounces of ether taken up in the gas as it passes through it, but you must remember that the 4 ounces of ether does not all go to the patient. There is a considerable volume of the gas escaping through the exhalation valve and a lot of this ether is wasted.

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TUBERCULOSIS OF THE CERVICAL LYMPHATICS

A STUDY OF SIX HUNDRED AND EIGHTY-SEVEN CASES

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Modern students of tuberculosis believe that tuberculous infection usually comes in childhood and that it may develop then, or be quiescent, or be cured. If quiescent, it may show renewed activity at later periods of life. Baldwin[1] says:

> Childhood is the time of infection, youth the time of superinfection, and that from extension of the primary disease.

McCleave[2] says:

> It is now generally conceded that infection with the tubercle bacillus is, in the majority of cases, an incident of early life, and that, regardless of the time of development of clinical symptoms, tuberculosis is, in its origin at least, essentially a disease of childhood.

Francine[3] says:

> This infection during childhood does not, as a rule, develop into pulmonary tuberculosis at that time, but lies dormant in the lymphatic system, or is latent until adult life, when it breaks forth or manifests itself in pulmonary localization. It is largely children infected by contact in their homes who furnish later the ever oncoming crop of consumptives.

A large number of similar quotations could be made to show the present general belief that primary tuberculous infection usually occurs in childhood and that this fact should be appreciated if we would combat the disease intelligently.

1. Baldwin: Bull. Johns Hopkins Hosp., 1913, xxiv, 209.
2. McCleave, T. C.: The Relation of Bovine Tuberculosis to Early Tuberculosis in Children, Am. Jour. Dis. Child., September, 1914, p. 210.
3. Francine, A. P.: The Underlying Factors in the Spread of Tuberculosis, The Journal A. M. A., March 7, 1914, p. 767.

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Tuberculosis of the neck lymphatics may be advantageously studied from this point of view. Childhood is the period when the infection most commonly comes; and this infection may be cured, it may lie dormant with the possibility of later activity, or it may extend rapidly. In each of these events it presents definite clinical pictures, and since the nodes are near the surface, there is a remarkable opportunity to study the peculiarities of the disease.

This paper is based on a study of 687 cases in which operation was performed by myself or by my associates or assistants under my observation during the last twenty-two years. The cases have been followed with great care. During a part of the time a special fund has been available for that purpose, and a great many patients have been brought to the hospital for inspection from time to time. The mass of observation thus accumulated has been large, although there is a limit to the possibility of tracing the class of people who live in the New York tenements. There were also periods when little "following up" was done. During certain parts of this time the greater portion of the patients have been children between the ages of 3 and 14 years, and the results with them have been wonderfully satisfactory. During other parts there have been many adults with widely disseminated tuberculosis, and the results with them have been discouraging. It seems best, therefore, to group the patients according to the period of development which their tuberculosis has reached and to study the characteristics of each group.

GROUP 1

Whether tubercle bacilli are inhaled with the air or swallowed with the food, the crypts of the tonsils, faucial and pharyngeal, offer possible lodging places. The faucial tonsils are particularly likely to harbor them. Enlargement of the upper cervical lymphatics promptly follows such infection, thus establishing what we may call the early stage of lymphatic neck tubercu-

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losis. The proper understanding of this stage is important.

The route of infection from the tonsil to the tonsillar lymph node is a very short one. This has been graphically described by Wood.[4] The tonsillar node is one of a group of nodes which lie beneath the parotid gland and the mastoid process and which are covered by the sternomastoid muscle. This group constitutes the first great line of defense against the invading tubercle bacilli. The invaders cause swelling, fibrosis, caseation and possibly abscess formation, but if the defense holds there is a distinct stage when the process is still local and has extended very little beyond this upper group of lymph nodes.

Figure 1 indicates the condition. Figures 2 and 3 indicate the appearance of patients who have this condition.

Of the 687 patients who form the basis of this paper, 452 were observed in this stage. Many of them, however, had somewhat more extensive inflammation than Figure 1 indicates. Since infections into the submental, submaxillary and parotid nodes also drain into the upper part of the jugular chain, some of them are also included in this group. The average age of the entire group was 8.03 years.

Sixty-seven of these patients were followed from six to twenty years; 23 were followed into the sixth year; 36 into the fifth year; 53 into the fourth year; 61 into the third year; 65 into the second year, and 49 into the first year; 98 were not observed after leaving the hospital; 91 per cent. of the patients traced were apparently cured when last seen; 8.75 per cent. showed slight evidence of recurrence; 0.25 per cent., that is, one patient, had died of intercurrent disease—typhoid fever; 8 per cent. had secondary operations during the period of observation.

Thus we see that for this class of patients the results are eminently satisfactory. It is hard to think of

4. Wood, G. B.: Am. Jour. Med. Sc., April, 1906, p. 620.

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another form of surgical operation which gives better results. These results were obtained in spite of bad hygienic conditions, since most of these patients had to return to insanitary tenement house surroundings.

It has been suggested that many of these cases had the bovine type of tuberculosis and that this accounts for the good results.

Drs. Park and Krumwiede[5] have examined many of these cases to determine this question. It is interesting to note their findings for patients from 5 to 16 years, which showed the bovine type in only 29.6 per cent.

GROUP 2

The patient's power of dealing with tuberculosis largely determines the stage of the disease in which we see him. Many of those in Group 1 seek surgical aid because abscesses form within the subparotid nodes, break through the node capsule and cause unsightly swellings. If these abscesses break and form sinuses, or if the inflammation progresses without abscess formation, the nodes along the entire jugular chain and those along the trapezius border may become enlarged. This constitutes another pathologic and clinical picture which we may study as Group 2. Figure 4 indicates the gross pathologic condition in this group, and Figures 5 and 6 show the appearance of two of the patients. There were 185 patients in this group. Their average age was 15.9 years, nearly double that of Group 1. Sixty-nine of them were over 20 years of age. Twenty-nine of these patients were followed from six to twenty years; 11 were followed into the sixth year; 18 into the fifth year; 14 into the fourth year; 24 into the third year; 19 into the second year, and 10 into the first year; 60 were not observed after leaving the hospital; 68.2 per cent. of the patients traced were apparently cured when last seen; 23.8 per cent. showed recurrences when last seen; 5.5 per cent.

5. Park and Krumwiede: Jour. Med. Research, 1910, xxiii, 205.

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had died of intercurrent disease, partly tuberculous; 2.4 per cent., or three patients, died in the hospital, two from hemorrhage, and one from thrombosis; 28.5 per cent. of the traced patients had two or more operations.

It is thus seen that the results obtained in Group 2 were greatly inferior to those obtained in Group 1. We believe that nearly all of these patients passed through the stage shown in Group 1. It would have been much better if they had had their operations then. Very few patients who have thorough operations when in Group 1 ever reach Group 2.

GROUP 3

There is another division, those with diffuse tuberculosis, which we may call Group 3. The patients show little power of resisting tuberculosis. The neck infection quickly involves a great number of nodes, and there are usually evidences of tuberculosis in other parts of the body. There were fifty patients in this group. Their average age was 12.7 years, about midway between Groups 1 and 2. Thirteen of these patients were followed from six to seventeen years; 3 were followed into the sixth year; 5 into the fifth year; 2 into the fourth year; 5 into the third year; 9 into the second year, and 6 into the first year; 76 were not observed after leaving the hospital; 1 died in the hospital; 34 per cent. of the patients traced were apparently cured when last seen; 43.2 per cent. were suffering from recurrences or other forms of tuberculosis; 20.4 per cent. had died of intercurrent disease, largely tuberculosis; 1 patient died in the hospital, soon after a minor palliative operation.

Figures 7 and 8 indicate the appearance of two patients in this group.

It is manifest that treatment of this type of cases is far from satisfactory. If, however, one third of them are apparently cured after long periods of observation, we have some encouragement.

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COMMENT

On studying these groups of cases it is easy to see why so much confusion exists about this subject. Certain types of cases predominate in individual clinics. Those observers who see mainly cases of Group 1 will have very optimistic ideas about the curability of the disease. For instance: One continuous sequence of 100 patients in this series showed 86 per cent. in Group 1. During the follow up work in which these patients figured, there were 106 patients examined: ninety-four of them were recorded as strong, vigorous, ruddy or in good health. Seven were recorded as pale or not strong, and only five were advised to have further operation for recurrences. On the other hand, when the work has been in a hospital, to which a different type of patients came — where many patients were in Groups 2 and 3, the results have been much less satisfactory, and complications and recurrences have been more frequent.

Much confusion exists about the term "operation" as applied to these cases. If the incision of an abscess, or the removal of a single node, is called an "operation," we shall have very poor operative results; if the term "operation" means the removal of all the enlarged lymph nodes in the neck, we shall have very good operative results. The most common error comes in those patients who have cold abscesses. When these abscesses are incised, a smooth layer of inflammatory tissue is found within. This constitutes the deep abscess wall, and seems continuous with the deep fascia. One may easily believe that the abscess comprises the entire swelling, and that there are no enlarged nodes still deeper in the neck, and in this belief, may be content with simply draining the abscess.

As a fact, these cases regularly have groups of nodes in the usual location beneath the sternomastoid muscle, and unless these nodes are found and removed, the operation is futile. The tubercular detritus, the so-called "pus" of the cold abscess, is no bar to thorough

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operation, since it seems to have little or no infective tendency, and healing takes place about as kindly as though it had not been present. Failure to appreciate the extent of the disease is a very common error. Inadequate and badly placed incisions and incomplete operations follow.

The technic of operation cannot be given in this paper.[6]

All operations should be done with due regard to the anatomy of the neck, and with careful precautions against nerve injury, particularly avoiding the spinal accessory nerve, and the lowest branch of the facial nerve. Transverse incisions give suitable exposures for the majority of the cases, and have the great advantage of leaving scars which do not stretch, and hence are almost invisible. With the aid of suitable retraction, extensive dissections can be done through these transverse scars. In the far advanced cases, however, the scar is not the important factor, and longitudinal incisions should be used, since they give easier access to the masses of enlarged nodes.

It is not the purpose of this paper to make exhaustive comparisons between the different forms of treatment which are used for this disease. There are many of them: Roentgen-ray, sea bathing, heliotherapy, tuberculin, Bier's hyperemia, etc. It is rather my purpose to call attention to the natural history of the disease, and to the results of the treatment which I have used. I have, however, visited various institutions in which these measures are used, both in this country and abroad, and have noted at least three elements which should be considered: (1) differences in diagnosis; (2) differences in interpretation of what constitutes an operation, and (3) differences in interpretation of what constitutes a cure.

6. Details of the technic used for most of these cases were published in Annals of Surgery, 1905, xlii, 49, and 1908, xlviii, 169. Judd (Ann. Surg., 1910, lii, 759) gives the details of operation for extensive cases by the posterior incision, and Mitchell (Bull. Johns Hopkins Hosp., 1902, xiii, 161) describes the operation by anterior incision.

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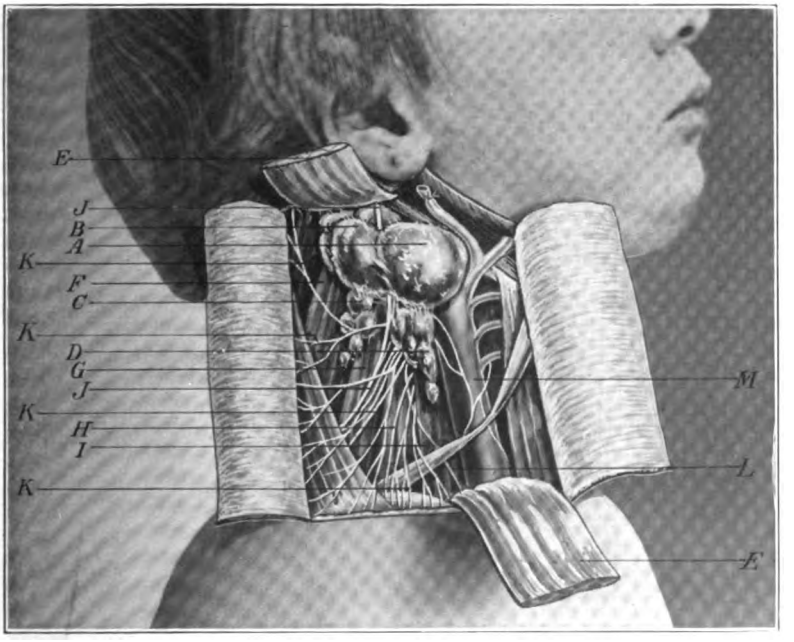

Fig. 1.—Early stage of tuberculosis of the neck lymphatics: *A*, tonsillar node, caseous; *B*, tuberculous nodes of the subparotid group; *C*, posterior nodes; *D*, nodes of the deep jugular chain; *E*, *E*, sternomastoid muscle; *F*, levator anguli scapulae muscle; *G*, scalenus posticus muscle; *H*, scalenus medius muscle; *I*, scalenus anticus muscle; *J*, *J*, spinal accessory nerve; *K*, *K*, *K*, *K*, branches of the cervical plexus; *L*, phrenic nerve; *M*, internal jugular vein.

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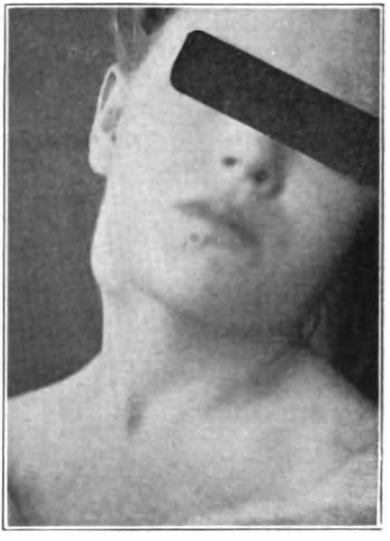

Fig. 2.—Patient in early stage of tuberculosis of the neck lymphatics.

Fig. 3.—Patient in early stage of tuberculosis of the neck lymphatics.

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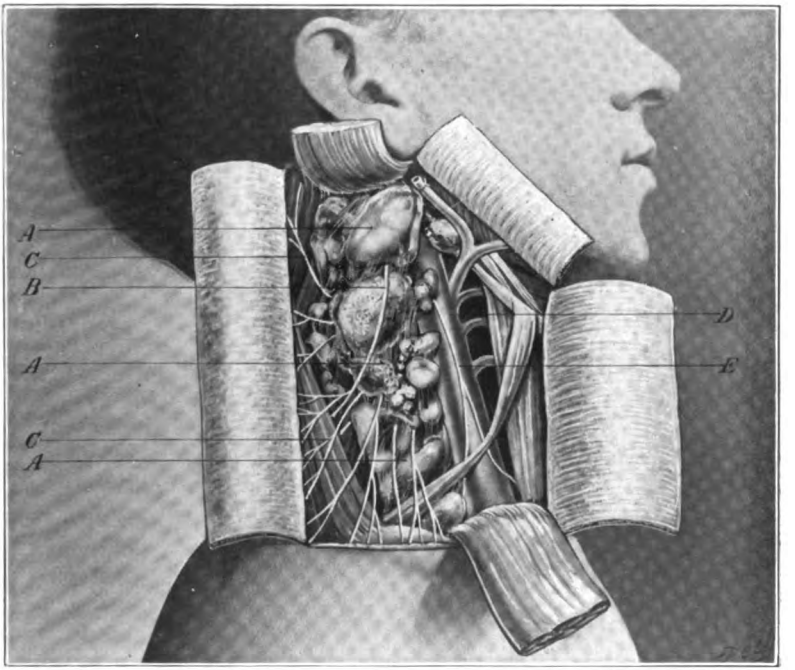

Fig. 4.—Late stage of tuberculosis of neck lymphatics: *A*, *A*, *A*, tuberculous lymph nodes; *B*, spinal accessory nerve; *C*, *C*, branches of cervical plexus; *D*, internal jugular vein; *E*, communicans hypoglossi nerve.

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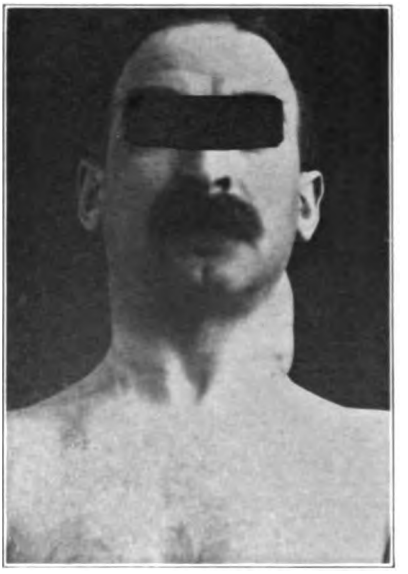

Fig. 5.—Late stage of tuberculosis of the neck lymphatics, Group 2.

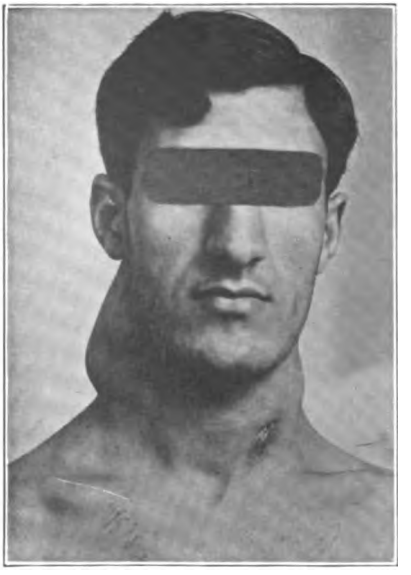

Fig. 6.—Late stage of tuberculosis of the neck lymphatics, Group 2.

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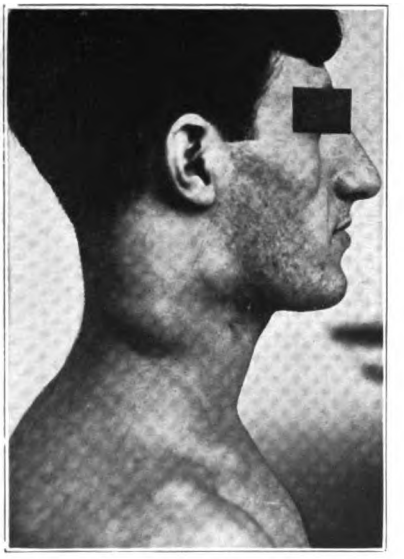

Fig. 7.—Late stage of tuberculosis of the neck lymphatics, Group 2.

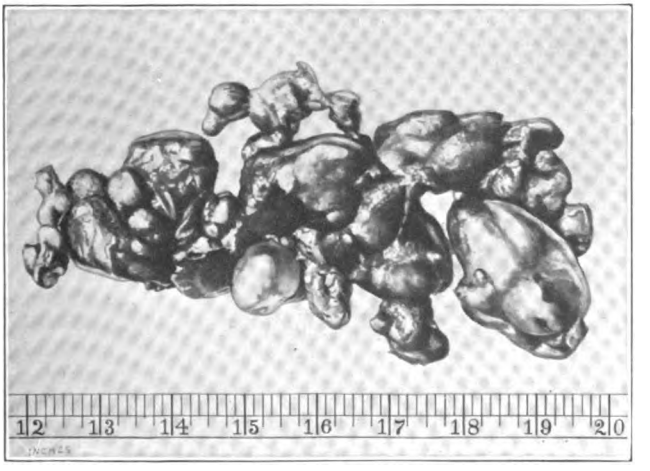

Fig. 8.—Chain of tuberculous lymph nodes removed from patient in Group 2.

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Fig. 9.—Patient with diffuse tuberculosis, Group 3.

Fig. 10.—Patient with diffuse tuberculosis, Group 3.

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1. Clinicians who do not have the opportunity of removing the lymph nodes and having them examined microscopically have come to consider many cases tuberculous which have not been so considered in this study. For example, Hawes says:

> In regard to the diagnosis of tuberculous adenitis, Allen believes that 60 per cent. of enlarged glands in children are tuberculous; Philip is of the opinion that enlarged cervical glands should be considered tuberculous unless there is definite indication to the contrary. It is my custom to consider these enlarged glands as tuberculous, if, on careful examination of the patient and treatment of all possible sources of infection, no other cause can be found.

It is manifest that on this basis many cases are treated as tuberculous which have not been so considered in our work, just as the older observers considered hip joint inflammations tuberculous, which we now know to be due to the pyogenic bacteria.

Very early in this study, such nodes, when removed, were found to show only hyperplasia; and since we do not advise the removal of hyperplastic nodes, every effort was made to avoid operation on them.

Dr. Farr, who saw many of these cases in the Wilkes Dispensary, states that probably five patients with hyperplastic adenitis apply there for every one with tuberculous adenitis. If a small proportion of them had been diagnosticated tuberculous, we would have had a very exaggerated idea of the curability of the disease.

2. It is astonishing to note the class of cases which are cited as operative failures. This has already been referred to. We do not talk about the operative treatment of appendicitis when the appendix is regularly left in position, nor about the operative treatment of cancer, unless every effort is made to remove all the cancerous material, nor do we talk about prostatectomy unless the prostate has been removed. We surely should not talk about the surgical removal of tuberculous neck lymphatics unless there is evidence that thorough operations have been done.

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3. There seems to be only one way of determining the condition of the lymph nodes, that is, to study enough of them after removal to form a fair comparison between the preoperative appearance and the postoperative findings. It is possible that a patient should have a ruddy appearance and yet should have masses of tuberculous lymph nodes in the neck. Such patients have been considered cured by careful and honest advocates of some of the methods of treatment here given, but have not been classed as cured in this study.

If, therefore, we make a comparison between operative and nonoperative methods of treatment, we must remember that those who see the lymph nodes, and those who do not see them, must of necessity have different conceptions of the conditions with which they are dealing. With this in view, we must believe that our patients should have the advantage of such forms of treatment as are likely to help them. If operation gives them the best likelihood of cure, they should have operation. If operation plus another form of treatment is desirable, they should have both. If another form of treatment gives a quicker and better cure, it should be used; but a patient should not be allowed to drag from Stage 1 to Stage 2 while indefinite forms of treatment are being tried, nor should he be kept under treatment for months, or even years, with discharging sinuses and disturbed health when a forty minute operation and ten days' after-treatment would result in cure.

ABSTRACT OF DISCUSSION

Dr. John F. Golden, Chicago: I think Dr. Dowd's division is the same as ours, that is, cases occurring in children and in adults. Tuberculosis of the cervical lymph glands in children has a tendency to cure itself without the aid of surgical intervention. In the adult it is quite different and the division might be carried to the descending infections which become limited in the chain. When it is stopped at a point and held, the patient's resistance tends to cure. There is still another type in which the tuberculosis of the cervical glands ascends from the mediastinum; also tuberculosis of the cervical

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lymph glands coincident with a tuberculosis of the lung, peritoneum or elsewhere. The differentiation of these types and the cure of the tuberculosis are accomplished not by removing the glands but rather by increasing the patient's resistance. We have found the tuberculin method the best. We use the standard solutions hypodermically both diagnostically and therapeutically, together with the administration of fats in the forms of an emulsion of cod-liver oil, butter and cream. We educate the patient to take his temperature at regular daily intervals as a control to the administration of the tuberculin. Uniformly in children we secure by this method a recession of the glands, some of them breaking down and discharging a cheesy substance, but uniformly progressing to a cure without enucleation. The usual diagnostic test used by us is one twentieth of a drop of pure tuberculin. This is given after the patient has been educated to take his temperature at three-hour intervals during the day. The temperature range from sixteen to twenty-four hours later is a good index to the extent of the infection and the degree of resistance of the patient. In cases in which we find a tuberculosis of the cervical lymphatics and the patient gives a great degree of reaction, temperature, nausea, vomiting and headache, there is as a rule a tuberculosis elsewhere.

Dr. Robert T. Morris, New York: Perhaps the majority of cases of tuberculosis of the lymph glands of the neck, in the various groups in young patients and in older patients in cases in which the glands have not already broken down, do not require operation at all, provided that the patient is so situated at hospital or in the private house that he may have the full benefit of our knowledge of the subject. First, I would emphasize that tuberculin must be used properly. Unless tuberculin is used properly it may be injurious. Next, increasing the general resistance of the patient is most important. The full meaning of that is not clear to any except those who have made a special study of tuberculosis and who know that no two patients are to be treated alike. In the cases suitable for local treatment, not operative, my best resource for dealing with many of these cases is along the lines of the Bier idea of hyperemia. In some cases we have had very successful results from using iodoform and oil injection. It is rather tedious and troublesome for young patients, who do not bear it well. They do not allow us to handle them. In other cases we have done well with Roentgen ray. But best of all has been the idea brought forward by Bier. In order to carry that out in suitable cases I have the patient rest the neck against a hot water bag for several minutes, then an ice bag, again the hot water bag for several minutes, then the ice bag for several minutes. Many children will play with their toys and older patients will read something which they had not the opportunity to read before because they have been

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too busy, if you persuade them that by carrying on the method of Bier hyperemia you may so stimulate the leukocytosis that tuberculosis disappears. It is a slow process and requires patience on the part of the patients. Most of these patients of all classes are curable without any sort of operation whatsoever, provided they are managed according to the best methods of today.

Dr. W. E. Ladd, Boston: For the last four or five years I have been following the teaching of Dr. Dowd. I cannot disagree with him on many points but would like to emphasize some. I have operated in about 160 cases of tubercular cervical adenitis, mostly in children. One hundred and thirty of these have been followed for from six months to five years. Of that number 93 per cent. are apparently cured, which is practically the same result as Dr. Dowd gets. The importance of the portal of entry should be emphasized. In my series of cases the tonsil was believed to harbor the primary focus in from 75 to 80 per cent. of the cases. Many of these have been examined microscopically and show miliary tubercles often situated close to the crypts or close to the posterior capsule of the tonsil. I believe it is just as illogical to remove the glands from the neck without removing the tonsils as to remove tonsils without removing the glands from the neck. In either case you leave tuberculosis behind. In removing the tonsil the capsule should be included as otherwise foci of tuberculosis may be left and be the starting of later trouble. I believe very strongly with Dr. Dowd that these cases should be taken when the glands are confined to the upper triangle of the neck, the subparotid group, when the operation is easier to perform and more effective. If you are going to wait and try tuberculin, hygiene without operation, Roentgen ray, heliotherapy and other forms of treatment you are going to let a great many cases progress to tuberculosis which is much more disseminated and much more difficult to cure. At the Children's Hospital in Boston, we get many cases which have gone for two or three years under other forms of treatment and present as the result a large number of sinuses—a difficult situation to handle. In the early cases the results of surgery are most satisfactory. One other point I believe to be worth mentioning is the type of infection. Raw's studies showing that surgical tuberculosis, that is, glandular and bone tuberculosis, does not exist in countries where cow's milk is not used, though phthisis is common, are suggestive. The work of Mitchell of Edinburgh who found that a very high percentage of these cases were due to the bovine type of bacillus is also suggestive that milk may be responsible for the high prevalence of this disease. If further investigations show this to be so the importance of furnishing a nontubercular milk supply becomes apparent.

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Dr. Willy Meyer, New York: Dr. Dowd showed that the very beginning of the trouble usually is that group of glands which is situated in the upper triangle of the neck. No doubt if we take these cases in time we will prevent further trouble. The difficulty is that we do not get these cases always at this period. Sometimes we see them with the big chain of glands in front and behind the sternocleido. I do not know a better method if patients have been sick for a number of years and the glands are hard and firmly adherent, than to make, in the male at least, an incision in front and behind the sternocleido and divide the muscle transversely, forming an upper and lower flap. Then taking the internal jugular as a guide we can make a thorough extirpation. In the female we must try to get along in such cases with one incision, posterior to the muscle and not running up so high, to avoid scarring as much as possible. For glands in the upper triangle there is no better incision than the one Dr. Dowd showed. Dr. Morris mentioned conservative treatment, and he touched on Bier's hyperemia. He has seen results follow alternating with heat and cold applications. We can simplify the treatment by having the patient wear an elastic bandage around the neck, an ordinary garter elastic, with a hook sewed on at one end and a number of eyes at the other, for eleven out of every twelve hours. Children as well as grown people do not object to it. On the contrary, it often reduces pain and stiffness. As soon as glands have broken down, aspirate and inject iodoform-glycerin, or stab the abscess and aspirate with a Bier's suction cup. I have seen very good results from this method, even in the presence of hard glands, which is very exceptional.

Dr. Charles N. Dowd, New York: The statement, that glandular enlargements in children's necks tend to subside, must be taken with reserve. The hyperplastic glands do subside; probably some of the tuberculous ones also subside; but the patients about whom this paper is written are the ones whose swellings did not subside. Most of them had had various forms of treatment before we saw them and came to us because the swellings failed to subside under this treatment. A more general understanding of the natural history of the disease is important. Nearly all the patients show the conditions of Group I at the beginning and have a great tendency to pass into the stages shown in Group II and Group III. The question of diagnosis is very important and has led to much confusion. Clinicians who do not remove the lymph nodes have a great tendency to call them tuberculous when they really are simply hyperplastic. I have had many consultations and conversations with them, have read their standards of diagnosis, have seen their patients and have removed some of the hyperplastic nodes at their request. It is manifest that any form of treatment which is applied

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to hyperplastic nodes is likely to be successful and is misleading if the clinician thinks he has cured tuberculosis. My associates and I have taken great pains to visit clinics where tuberculin is used, since we are earnestly seeking the best way to cure this disease. I can mention one tuberculin clinic where there were more patients than in any other part of the institution to which it belonged and where I saw a whole series of these patients. There was not a single one who seemed to be cured by tuberculin. There were a number of patients who had lumps which needed operation; and there was one who had had a good operation and had only been treated with tuberculin for the induration which followed. The opinion held in that clinic was that when the patients ceased to be hypersensitive to tuberculin they were cured, even if they still had enlarged glands. The difference in opinion as to what constitutes an operation has led to great confusion. Patients are shown as operative failures who never have had thorough operations. The location of the scars makes this certain. The point which I especially wish to emphasize is that it is not fair to let patients drag along from Group I to Group II or III while something is being done which simply hides what is going on within the neck. We ought to take care of these patients in the curable stage, the same as we take care of patients with appendicitis, gall-bladder inflammation or kidney stones. Take care of them when you can cure them and do not let them drag along.

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BISMUTH PASTE IN CHRONIC SUPPURATIVE SINUSES AND EMPYEMA

INCORRECT TECHNIC AS A CAUSE OF FAILURE IN ITS APPLICATION

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The prevalence of suppurative sinuses has greatly diminished during the past decade. This is due partly to our ability to prevent their formation by treating cold abscesses and joint diseases more scientifically, and partly to the employment of the newer and more effective methods of treatment of sinuses when they already exist.

The present war in Europe, however, will result in a tremendous increase in this class of cases. I am informed that Dr. Alexis Carrel, from one of the field hospitals of France, that nearly every case of gunshot wound is infected before it reaches the hospital. Dr. Carrel further reports that these gunshot and shrapnel wounds are followed by suppurative sinuses, and that there are thousands of such cases in France. No doubt, the other belligerent countries are having the same experience, so that after the war is over there will remain for years an army of invalids with these chronic suppurations.

It is principally for this reason that I am tempted again to present the subject of treating this class of cases.

Ten years have elapsed since the bismuth treatment of suppurative sinuses and abscess cavities was introduced into surgery. During these years this method of treatment has been given a most thorough and impartial trial. When first introduced, surgeons in

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this country and abroad readily took up the method, because it appealed to them as a rational treatment, and because my report contained such surprisingly successful results. Besides, the material at hand was plentiful, and patients were willing to submit to any form of operative or nonoperative treatment which gave the slightest prospect for a cure.

Shortly afterward there came reports from the various clinics. Some surgeons showed far better results than my own, others less favorable results, and in the hands of a few the procedure was more or less a failure. Undoubtedly these reports represent only a fraction of the cases in which the treatment was employed, for many country practitioners who used the bismuth treatment did not report their results. The accompanying table presents the statistics recorded in the literature.

This series of 527 cases (319 nose and throat cases excluded), from so wide a range of sources, gives an average of 80.64 per cent. of cures, the lowest being 12.5 per cent., and the highest, 100 per cent.

How can we explain the lack of uniformity in results? To ascertain this I have made observations in clinics here and abroad, I have conferred and corresponded with surgeons, and finally I have come to the conclusion that faulty technic is the chief cause of failures.

At the North Chicago Hospital, where the method was started in 1906, we have had exceptional opportunities for treating suppurative sinuses and abscesses with this method, the material now amounting to over 1,800 cases, which includes almost every variety of suppurative disease. No doubt, we committed many blunders before our technic was perfected; but I feel that with accumulated experience and from what I have learned through my own mistakes and those of others, I am now in a position to outline for the profession a technic which will assure good results to those who will follow the rules.

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I shall at this time make no reference to the statistics of my own results. The members of the profession are not so much interested in what the author of a method can do, as in what they themselves are able to accomplish.

PATHOLOGY OF SINUSES

In order to carry out the treatment rationally and intelligently, one must be familiar with the pathology of suppurative sinuses and of the manner in which they originate.

We must bear in mind that a sinus is nothing more than a contracted abscess cavity. Its formation usually takes place in the following manner:

After an abscess has formed, the increasing pressure of pus within the pus cavity will undermine the tissues in various directions, until the abscess has reached a place near the surface of the body or some hollow organ, such as the intestine or bladder, where it will break through and empty its contents. The usual route is along the muscle sheaths or fascia, the abscess opening at times quite a distance from its origin. In one of my cases a psoas abscess opened above the clavicle, and the resulting sinus was thought for a time to be a broken-down tuberculous gland, until the paste injected into it escaped from a second sinus near the sacrum. This cleared up the diagnosis.

After an abscess has emptied its contents, a shrinkage of the walls takes place so that after a time only a narrow channel, or sinus, remains. Sometimes these channels undermine the tissues to such an extent that a complex network of sinuses results. This fact is illustrated in Figure 1, representing a hip-joint disease in which the abscess perforated the acetabulum and undermined the pelvic fascia.

When small abscesses lock themselves off, they empty their contents in different regions. This explains the multiplicity of openings. I have seen as many as forty openings resulting from a knee-joint tuberculosis.

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Sinuses frequently open into the bowel or bladder in addition to other openings on the skin, and thus fecal matter or urine may escape from the skin sinuses. Recently I published the report of a series of such cases, and desire to cite two of unusual interest, one illustrating a urinary, and the other a fecal fistula, and the technic to be employed in such cases:

CASE 1.—*Rectal and urinary fistulas resulting from hip-joint disease and spinal tuberculosis.*

I. B., woman, aged 35, had developed hip-joint disease and spinal tuberculosis at the age of 9. After a number of years of conservative treatment, abscesses formed around the hips and in the lumbar region. Several of these were incised and others opened spontaneously. At the age of 20 she had ten discharging sinuses. During the past ten years she had undergone a number of surgical operations, none of which were of avail. At the age of 28 she joined the Christian Scientists, and became a most devoted disciple of that cult, receiving their constant treatment for eight years.

I saw her in 1909; she could not walk but could manage to get out of a very low bed to urinate about every half hour. The cystitis was the result of a perforation of a sinus into the bladder. Another sinus perforated into the rectum and another about 1 inch from the anal opening.

Here we have a coexistence of a hip and spinal tuberculosis which has produced a rectal and vesical fistula, a most distressing combination.

The bismuth treatment had the effect of closing both the fecal and the urinary fistulas, but several of the suppurative sinuses persisted. The patient was soon able to be up and walk for blocks, and resumed her worship at the nearest Christian Science church. In all sincerity she attributed her improvement to her faith in Christian Science. In order not to hurt my feelings, she declared that I myself was a Christian Scientist, but was not aware of the fact.

CASE 2.—*Hip-joint disease causing pararectal abscess and fecal fistula; twenty years' suppuration; closing of fecal and suppurative fistulas with bismuth injections.*

C. T. H., man, aged 30, had had a right hip-joint disease since childhood. At 10 the necrosed head of the femur was removed; several sinuses leading to the hip-joint remained, which kept on discharging for the past twenty years and required dressing twice daily. His health was naturally very much deteriorated.

I saw him in January, 1913. He felt a swelling in the perineum and pain in the rectum. On account of high temperature, I opened this pararectal abscess and evacuated a

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STATISTICS FROM THE LITERATURE

Author	No. of Cases	Condition	Percentage of Cures
Ochsner, Chicago	20	Tuberculous sinus	55
Ridlon and Blanchard	17	Tuberculous sinus	53
E. G. Beck, Chicago	192	Collective report	64
Robitschek, Minneapolis	9	Tuberculous sinus	55
Don, Edinburgh	...	Tuberculous sinus	17
Rosenbach, Berlin	4	Tuberculous sinus	50
Dollinger, Budapest	16	Tuberculous sinus	12½
J. C. Beck, Chicago	319	Nose and throat cases	22
Pennington, Chicago	17	Rectal fistulas	76
Baer, Baltimore	12	Tuberculous sinus	33½
Stern, Cleveland	4	Tuberculous sinus	100
Steinman, Munich	5	Tuberculous sinus	20
Bogardus, U. S. A.	1	Tuberculous sinus	100
Vidakovich, Russia	2	Empyema	100
Nemanoff, St. Petersburg	6	Empyema	100
A. J. Ochsner, Chicago	14	Empyema	85
E. G. Beck, Chicago	11	Empyema	82
Ely, New York	14	Tuberculous sinus	43
Hines, Cincinnati	9	Tuberculous sinus	89
Cuthbertson, Chicago	1	Intestinal fistula	100
Sandor, Sag., Budapest	2	Otologic	100
Heitz, Boyer, Morens, Paris	11	Renal sinuses	73
Zollings, Zurich	25	Tuberculous sinus	54
Schober, Philadelphia	5	Tuberculous sinus	80
Gessner, New Orleans	4	Tuberculous sinus	50
Schmid, Vienna	15	Tuberculous sinus	30
Rivera, Porto Rico	8	Tuberculous sinus	75
E. Goror, Paris	3	Tuberculous empyema	66
Reichelfelder, Washington	4	Tuberculous empyema	75
Brandes, Kiel	29	All varieties of sinuses	76
R. Beck, Chicago	58	Alveolar sinuses	54
R. Beck, Chicago	9	Empyema antrum	66
Collective reports from 19 dental surgeons in U. S. A.	39	Alveolar sinuses	74
Collective reports from 19 dental surgeons in U. S. A.	4	Empyema antrum	100

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large amount of pus. Inserting my finger into the cavity, I felt and removed three small spicules of bone. I noted that this cavity communicated with the bowel higher up and discharged a large amount of malodorous pus mixed with fecal matter. This fecal mixture kept discharging for weeks, so that a semblance of cleanliness could not be maintained.

Bismuth injections were begun, and the closure of the fecal as well as the suppurative rectal channels was accomplished in a remarkably short time. The patient gradually improved in general health, but not all the sinuses closed. Injections were repeated at intervals of a month, and small spicules of bone extruded themselves from time to time.

At present he reports that only one sinus near the hip is open, discharging only a few drops of serous material, and that he is able to work on the farm. Figure 3 illustrates injected sinuses.

Comment.—1. Radical surgical interference in such a case is strictly contraindicated.

2. Small sequestrums are frequently the cause of continued suppuration and must be removed.

3. Hip-joint disease may at times cause pararectal abscesses and may be mistaken for a rectal fistula.

4. A fecal fistula will often heal while the pus discharge continues. A diseased process higher up is usually present.

SINUSES MISTAKEN FOR RECTAL FISTULAS

About 20 per cent. of all cases of diagnosed rectal fistulas are not rectal fistulas at all, in the true sense of the word, but are sinuses which resulted from spinal tuberculosis, hip-joint disease or intrapelvic abscesses. This statement may surprise a good many, but I am able to confirm it by a series of over a hundred cases. The gravitating abscesses happen to open so near the rectum as to be mistaken for rectal fistulas.

In a series of 138 cases of hip-joint disease in my own practice, which I recently tabulated, I find six cases in which a rectal fistula (?) resulted from hip-joint disease, and the communication between the hip-joint and the rectal fistula is illustrated in every one of them. I cite one of the cases in this connection:

CASE 3.—*Hip-joint disease complicated with fecal and pararectal sinus and paravesical abscess; closure after bismuth injections.*

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C. V., man, aged 26, had been well to the age of 14, when he suddenly developed a severe pain in the right knee. A day later the pain shifted to the hip. The trouble was diagnosed as rheumatism (?).

Abscess in the hip followed and was opened at home; a drainage tube was inserted, and a secondary infection took place. Two years later the patient was operated on in Iowa City. After operation the sinus remained closed for five months, but spontaneously reopened. Thereafter sinuses appeared in different regions of the hip, and finally a pararectal abscess formed, which was opened and drained.

He came to me in January, 1912. The right limb was about 3½ inches shorter than the left. Bismuth paste was injected, and after three injections all sinuses closed. Two weeks later the patient could walk around without crutches, which he had not done for years. He remained well for two years, but in December, 1913, suddenly developed a severe pain in the region of the lumbar vertebra. He kept on getting worse, the pain extending anterior to the bladder. He had frequent urination, vesical tenesmus and great tenderness over the bladder. He returned to Chicago immediately, and I found a bulging over the old pararectal scar. I incised it and evacuated about a pint of reddish pus, which was mixed with fecal matter. It was thus evident that communication must have existed between the rectum and this abscess.

The injection of bismuth revealed a most instructive condition. The paste filled out all the pararectal sinuses which originated from the old hip-joint disease, and communicated with them. There is a side branch which through a narrow channel turns forward, anterior to the bladder, and fills up a cavity about 3 inches long and about an inch wide. This can be observed only in the stereoscopic roentgenogram. A single plate gives rise to a false interpretation (Fig. 2).

After two more injections the secretions became serous; fecal matter, as well as pus, stopped discharging, and the patient regained his health with unusual rapidity, and is perfectly well today.

Comment.—The instructive features in this case are: 1. It proves that hip-joint disease can produce a fistula around the bladder and is likely to perforate into the bladder. 2. A fistula which opens near the rectum may originate in the hip-joint. 3. Such cases as this may be regarded as inoperable and still curable by this simple method of injection. 4. There is one remarkable phase of this case: In spite of entire destruction of the hip-joint, the patient has perfect motion and normal strength in his limb. There is a shortening of about 3½ to 4 inches. He can stand on the affected limb as long as on the sound one. There is the same amount of flexion as in the healthy limb, although the entire head of the femur has been destroyed and absorbed (Fig. 4).

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That a sinus resulting from a spinal tuberculosis may be mistaken for a rectal fistula is clearly illustrated by the following case:

CASE 4.—A man, aged 53, developed what was thought to be a pararectal abscess twelve years before I saw him. It was incised, and a fistula remained. During the next twelve years he had three extensive operations for rectal fistula, the last resulting in incontinence of feces.

I saw him in July, 1913, in London, Canada. He had been on a cot for nearly two years. The discharge was so profuse that he had to be dressed three or four times a day in order to preserve a semblance of cleanliness. The rectum was gaping, so that one could inspect about 4 inches without a speculum.

A week later he came to Chicago. I injected the pararectal sinus with bismuth paste and took a roentgenogram (Fig. 5). This revealed the fact that the supposed rectal fistula originated in the eleventh dorsal vertebra and caused multiple abscesses and sinuses in the abdomen, all communicating with the rectal sinus.

This was evidently a case of tuberculous spondylitis, the psoas abscess opening near the rectum.

The therapeutic result was very satisfactory. The sinuses began to close, the patient gained rapidly in weight, and three months later he left the hospital with only one sinus in the rectum discharging a small quantity of pus.

ADVANTAGES OF THE BISMUTH METHOD

Having now a clear picture in our minds as to the origin and formation of fistulas and sinuses, we appreciate why some of our operations in the past have not produced the desired results. To dissect a fistulous tract of only a few inches' extent, such as we find in the ordinary cases of rectal fistula, may be feasible, but to attempt the dissection of a network of fistulas, such as are shown in these roentgenograms, is obviously impossible. Most surgeons can recollect cases in which they have attempted this and had to give up in despair, after one or two hours of work.

In the employment of the bismuth method, we have two advantages: first, it helps to avoid useless operations, and second, it produces results without operation.

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The method in question has been described in my previous publications, but I shall here briefly refer to the modus operandi. It consists of injecting a quantity of bismuth paste[1] (liquefied by heating in a water bath) into the opening of a sinus until one feels reasonably certain that all the ramifications have been filled. The paste thus injected will rapidly thicken and remain in the sinuses long enough to permit the taking of a roentgenogram. The bismuth, having the physical properties of producing a shadow on the sensitized plate, will give a clear picture of the existing channels of sinuses. If a set of stereoroentgenograms are viewed, the sinuses appear more distinctly, and their relations to the surrounding structures can be satisfactorily estimated. Such pictures will convince even the most skeptical of the value of this diagnostic method. In former years we relied on the probe and colored fluids as pathfinders of these sinuses, but such means may be used as guides only during an operation, as one can readily understand that a probe could never reach the depth of the sinuses shown in these roentgenograms.

When a sinus is very long and tortuous, the paste should be injected in a liquid state, so that it will flow readily into every part of the tract. If there is more than one opening, the paste is liable to escape from the nearest one and thus miss the remaining channels. To avoid this technical error, the mouths of all the other sinuses should be compressed by an assistant, by placing the finger tips against these openings, so that the liquid will flow in other directions, filling up all channels of the sinuses. It is essential that every crevice should be filled at one injection; otherwise there will be a recurrence of suppuration.

A striking example is given in the following case, showing how easily one could miss the focus of infection by faulty technic:

1. This paste is composed of: bismuth subnitrate, 30 parts, and yellow petrolatum, 70 parts.

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CASE 5.—*Tuberculous spondylitis first mistaken for hip-joint disease, then for a perinephritic abscess, and finally proved to be tuberculosis of the spine.*

A. C., woman, aged 25, developed two years ago pain in the lumbar region. Two months later there was a great deal of pain in the right hip and knee. Below the greater trochanter a fluctuating abscess appeared, which was opened and drained by her physician. She developed high fever, night sweats, became much emaciated and was unable to move. Thus condition persisted two years, when she was brought to me for treatment with a diagnosis of hip-joint disease and a discharging sinus.

The diagnosis was based on the fact that the abscess opened near the hip, that there was pain in this region, and a contracture of the limb toward the median line, such as very often follows hip-joint disease.

A roentgenogram, before the injection, demonstrated that the hip-joint was free from disease. An injection of bismuth paste, as shown in Figure 6, proves that the sinus extended from the opening on the outer side of the right thigh, along the adductor muscles, underneath Poupart's ligament, following the psoas muscle sheath toward the region of the kidney. In this region there was an accumulation of a large quantity of paste. A stereoscopic roentgenogram indicated that we had to deal with a perinephritic abscess, which had gravitated and opened at the external side of the right hip.

An operation was decided on to produce counterdrainage for the existing perinephritic abscess, and under local anesthesia the abscess was opened and large quantities of pus and paste escaped. The patient, however, did not improve, and quantities of pus kept discharging. I became suspicious that we had not yet struck the right place, and therefore decided to inject the abscess cavity in the lumbar region and carefully prevent the escape of the paste through the original sinus at the hip. This was done by using a large syringe containing 2 ounces of the paste in very liquid state, and compressing the channel above Poupart's ligament by external pressure during the injection, thus forcing the paste into other directions.

To my surprise, I found that the paste passed through the twelfth dorsal vertebra into another abscess on the left side. This is shown clearly in Figure 7. The abscess on the left side in the region of the kidney was then opened and drainage produced.

Even with this additional drainage the patient kept on declining, and for a time we thought she could not live; but the injections were continued at intervals of one week for the period of a year. Special care was taken to reach the focus in the twelfth vertebra.

A gradual improvement took place, and now, three years later, the patient is able to be up and about, with a slight discharge from one sinus.

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Fig. 1.—Injection of sinuses from tuberculous hip, showing narrowing of channels of preexisting abscess cavities.

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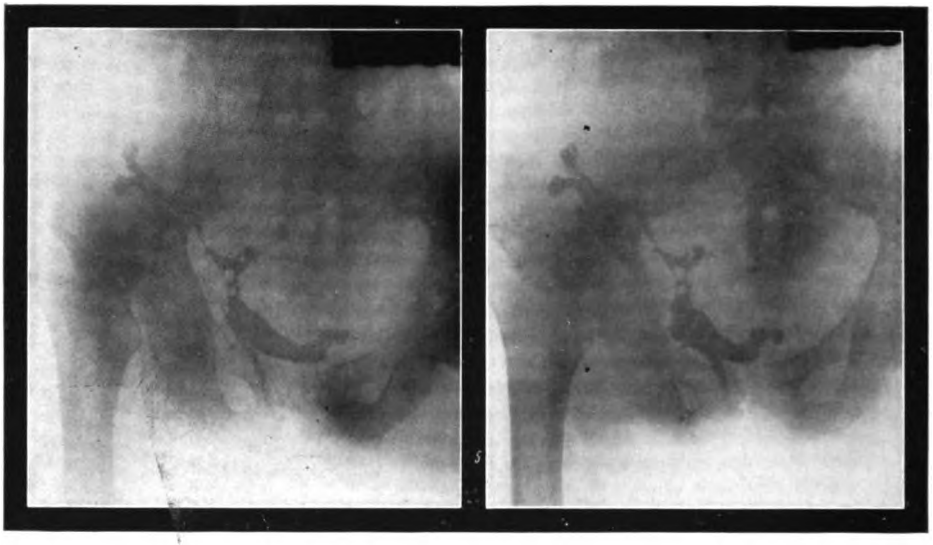

Fig. 2.—Recital fistula, originating from hip joint disease; coexisting paravesical abscess.

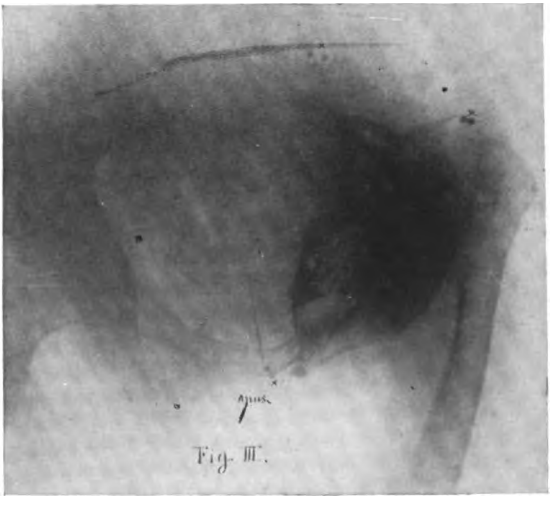

Fig. 3.—Rectal fistula, originating from hip joint disease; ischium absent, destroyed by tuberculosis.

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Fig. 4.—Flexion and extension in healed out hip joint disease after injection; head of femur absent. See roentgenogram (Fig. 3).

Fig. 5.—Rectal fistula, proved by bismuth injection to be a tuberculosis of the eleventh dorsal vertebra.

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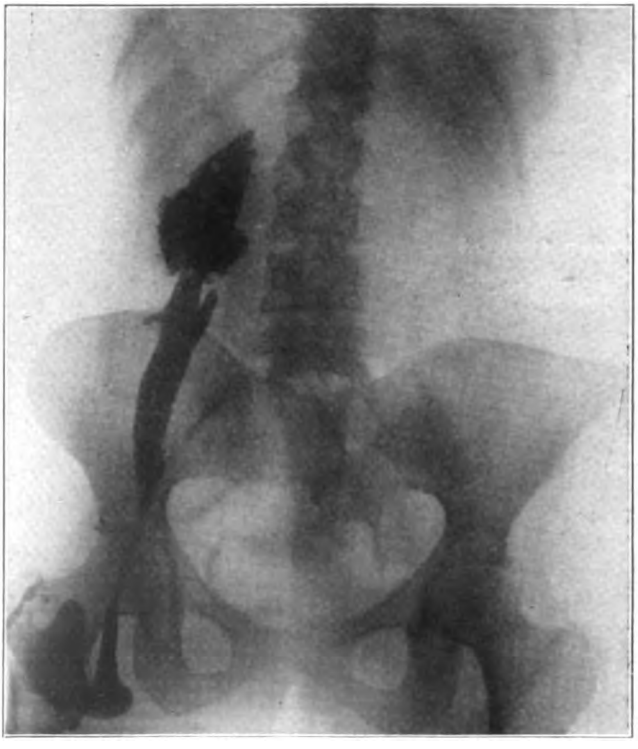

Fig. 6.—Supposed hip joint disease, appearing to be a paranephritic abscess, with subsequent injection, proved to be a tuberculosis of the twelfth dorsal vertebra (see Fig. 7).

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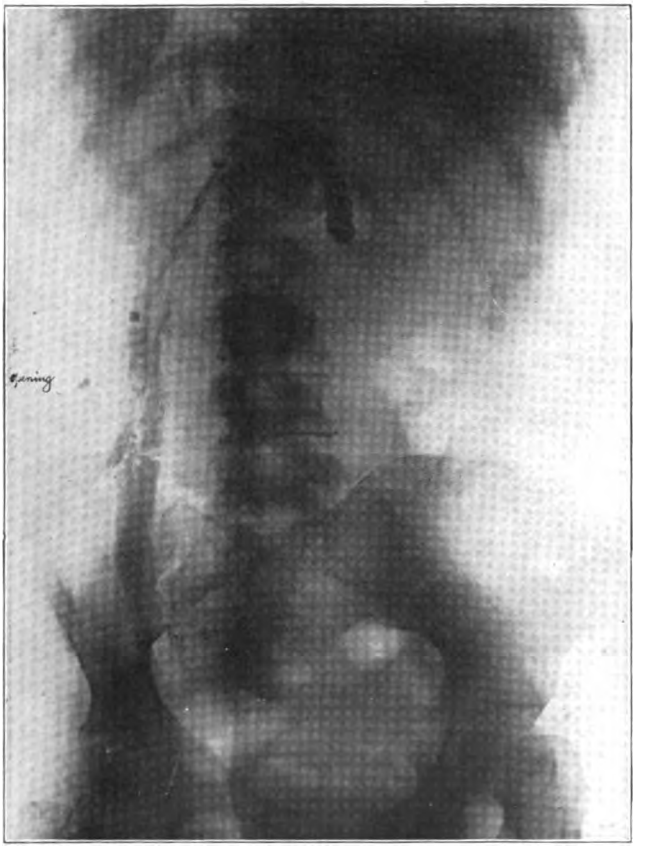

Fig. 7.—Proof of origin in twelfth dorsal vertebra by second injection.

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Fig. 8.—Osteomyelitis of radius with twelve suppurating sinuses.

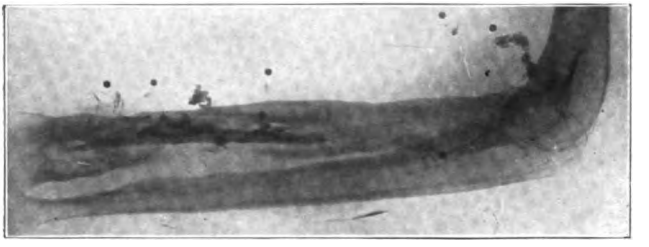

Fig. 9.—Sequestrum of radius.

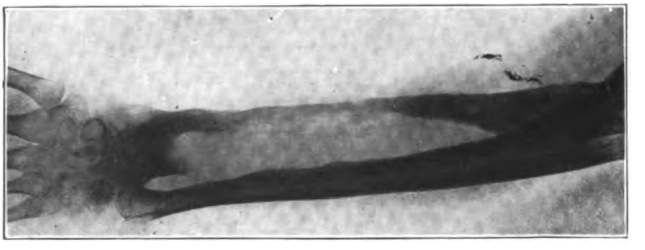

Fig. 10.—Sequestrum removed, showing a strip of radius preserved for regeneration of bone.

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Fig. 11.—Final result after bismuth injections.

Fig. 12.—Illustration of strength and function of the healed forearm.

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COMMON TECHNICAL ERRORS

What are the technical errors usually committed by practitioners?

1. The bismuth may not be sufficiently incorporated with the petrolatum and the paste therefore contains small lumps of pure bismuth, which interfere with the injection of the narrow sinuses. A little water accidentally dropped into the mixture will produce a solution similar to that of curdled milk. The paste in such a state is unsuitable for the treatment.

2. The mixture is not heated sufficiently to become liquefied. As a result, part of the tract becomes clogged and many of the ramifications are not reached at all.

3. The instruments are often improvised and not suitable for this form of treatment.

4. Undue force is used in the injection, tearing the tissues and forcing the paste and pus into freshly produced wounds. This may cause serious complications.

5. An incomplete filling of the entire sinus tract is the most common error, which is responsible for more failures than any other cause.

6. The sinuses are injected too frequently by some practitioners.

7. Patients are at times allowed to dress their own wounds, reinfection usually following.

8. Physicians at times do not give the paste sufficient opportunity to do the work. Results are not always immediate. Patience and persistence are essential factors in the success of the bismuth paste treatment.

METHOD OF PROCEDURE

For practical purposes the procedure in the average case is here given. Let us take, for example, a case of tuberculous coxitis of long standing, with multiple suppurative sinuses:

1. Preliminary to the treatment, a set of stereoroentgenograms of the affected region is taken, to make sure that there are no foreign bodies or sequestrums present. If they were present, they might be overlooked after the bismuth had been injected, because the shadows produced by the bismuth would obliterate the shadow of the foreign body.

2. Bacteriologic examination of the secretion is the next step. Smear preparations, cultures, and, in some instances, inoculation of guinea-pigs, are made.

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3. The sinus is now ready for injection. No attempt should be made to irrigate the sinuses with antiseptic solutions, nor should any drying out process be tried. The skin surrounding one of the sinuses is washed with alcohol, and the tip of the glass syringe, which has been filled with the liquefied paste, is placed firmly against it, and the paste slowly but firmly forced into its channel until it is seen to escape from the nearest opening. Then the finger is quickly placed against this opening to prevent the escape of the paste, and the injection is continued until the patient begins to complain of some pressure. If there are many openings, an assistant must occlude all of them with his fingers during the injection, in order to be certain that all the branches of the sinuses have been filled.

4. After the injection another set of stereoscopic roentgenograms is taken, which will give a clear picture of the entire network of sinus tracts and sometimes be the means of tracing the path to the focus from which the disease originated.

5. A sterile bandage is then applied and the patient put to bed, for a few hours, or a few days, depending on the severity of the case. In subsequent treatments the patients are usually allowed to walk about immediately after the injection.

6. The first dressing is done the following day. If the discharge, which before injection was creamy or profuse, has changed to a serous consistency, it is to be regarded as a favorable sign, and a microscopic examination will usually prove it to have become sterile. If the discharge is sterile, the sinuses need not be reinjected unless they later become reinfected. It is not intended that the paste remain in the sinuses. It will gradually exude, and within a week only traces may be found by flouroscopic examination or by roentgenogram.

7. Should the discharge persist and remain purulent, the injections should be repeated at intervals of from five to six days for a reasonable length of time (from four to six weeks), and if after this period there is no appreciable improvement, one must search for the cause. A sequestrum may be present, or the focus of the suppuration be in such location as to be inaccessible to the paste, as, for instance, in the cancellous structure of long bones.

In such cases, either the foreign body must be removed, or, as the case may be, the infected cancellous structure of bone curetted, and the bismuth injections resumed.

For illustration of case with sequestrum, I cite the following:

CASE 6.—*Osteomyelitis of ulna, with twelve sinuses and sequestrums.*

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Miss F. B., aged 17, had diphtheria at the age of 8, and has had chronic tonsillitis ever since. Three years ago a swelling developed in the right wrist, but gradually the entire arm was undermined with pus, and abscesses formed which were incised and drained. The elbow joint became ankylosed, and the sinuses persisted in discharging.

The patient came with the request to have the arm amputated above the elbow.

Examination, Aug. 9, 1915, revealed the right forearm and wrist and above the elbow studded with twelve suppurative sinuses, discharging foul and creamy pus (Fig. 8). The elbow was entirely ankylosed, the fingers and wrist stiff and swollen. There was a swelling about 3 inches in diameter on the left side beneath the scapula, fluctuating and red on the surface, and also a discharging sinus on the right ankle.

Steroscopic roentgenograms (Fig. 9) showed distinctly a large sequestrum of the ulna, taking in almost the entire length of the bone.

A conservative operation was decided on, instead of amputation. Under general anesthesia the sequestrum was removed through a long incision, and the larger part of the diseased ulna was removed, except the external border and the articular joints at the wrist and elbow, which were left in order to preserve the contour of the arm and leave enough healthy bone for regeneration (Fig. 10).

The essential point in the after-treatment was to treat the wound open. Not a single stitch was put in, and the wound was packed with gauze. Three days later the gauze was removed and the entire cavity filled up with bismuth paste and bandaged. The incision gradually closed by contracture of the wound edges.

The remaining sinuses on the flexor surface were injected, and all healed within a few weeks, so that the patient has at present a useful arm, without any suppuration (Fig. 11). She has developed strength in the muscles, and can perform all housework, lifting heavy articles, such as chairs (Fig. 12), but she still has an ankylosis in the elbow, which we shall try to remedy by subsequent plastic operation.

The sinus on her right ankle was injected once and healed out, and the cold abscess underneath the scapula was treated with the prophylactic method, which I advocate, the abscess being incised and 5 per cent. bismuth paste being injected, and it healed promptly. (Patient exhibited.)

PREVENTION OF BISMUTH POISONING

Great care should be taken not to retain too large a quantity of the paste in large pus pockets for too long a time, because of the possibility of gradual absorption of the bismuth, which is liable to produce toxic effects and even fatal poisoning.

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In 1909 I reported the first case of this form of poisoning.[2] At that time I warned the profession against the indiscriminate use of the paste, and this, no doubt, put many on guard who thought that bismuth was an entirely harmless substance. The occurrence of this accident has deterred many surgeons from employing the bismuth treatment, and since poisoning can be avoided, it would be deplorable that an otherwise useful method should not be employed on this account. Although the bismuth treatment is now used more extensively than ever before, there has not appeared in the literature any case of bismuth poisoning for the past few years. That this complication may be avoided is evident from the fact that in our series of over 1,800 cases treated at the North Chicago Hospital, we have not had a single fatal case.

It is, of course, possible that there are persons who have an idiosyncrasy against bismuth and a special susceptibility to its absorption, and may develop toxic effects from bismuth in small doses; but such cases must be very exceptional, when we stop to consider that in 1,800 of my own cases, not a single patient had this idiosyncrasy. Are we to discard an otherwise useful method because of the possibility of encountering such a case? Certainly not; we do not discard ether or anesthesia because there are fatalities on record from its employment.

Should toxic symptoms appear, the paste must be removed by washing out the cavities with warm olive oil. The sterile oil should be injected and retained from twelve to twenty-four hours, in order to produce an emulsion with the bismuth mixture. This emulsion should be withdrawn by means of a catheter or suction syringe. After its removal, all symptoms will promptly disappear. Scraping out the paste with a scoop is a dangerous procedure, because it opens new channels for absorption.

2. Beck, E. G.: Toxic Effects from Bismuth Subnitrate, The Journal A. M. A., Jan. 2, 1909, p. 14.

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SUMMARY

1. Failures in the application of bismuth paste are principally due to faulty technic or carelessness.

2. The treatment has passed its experimental stage, and the results obtained by surgeons all over the world warrant its more general employment.

3. Stereoroentgenograms should be employed to control the treatment and to prevent useless operations.

4. Bismuth poisoning can be avoided, and is now a rare occurrence.

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ABSTRACT OF DISCUSSION

Dr. Albert J. Ochsner, Chicago: In discussing cases that are suitable for treatment with bismuth paste injections we must first consider the mechanical conditions present. Canals extend in a number of irregular directions, with usually enlargements at various points, and little lakes here and there. The progress of the disease is by pressure, pressure necrosis or gravity pressure. Surgery alone cannot discover all these canals and lakes, but the bismuth injection does; hence Dr. Beck's treatment is of such great value. In the first place, he produced a condition favorable for disposing of granulation tissue; second, he disposed of accumulations which increase in amount and continue the pressure necrosis unless removed. Third, bismuth possesses a certain antiseptic quality, as does also the petrolatum, because it has been shown that microbes cannot live when they are mixed up with fatty substances. Now regarding the application of the treatment: Whenever a surgeon has told me that he has not been successful in the use of Beck's paste, I have invariably found that he has not applied the paste in the manner that Dr. Beck has told us it should be applied. I have seen it applied so that instead of merely filling these spaces it would tear the tissues and force the septic material into new spaces. No wonder the patients had an elevation of temperature afterward and their condition became worse! From their point of view the treatment did no good. It is essential, therefore, to inject the paste very slowly and continuously so that it will fill not only the nearest spaces but all spaces, taking the place of the septic material, substituting antiseptic material from which there is no absorption for septic material. Scarcely a day passes that we do not use the paste in our hospital and the results are just as Dr. Beck has described them.

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Dr. Emil G. Beck, Chicago: The formula we use now is: 30 per cent. subnitrate of bismuth; 70 per cent. petrolatum. In empyema cases I have lately used a 10 per cent. mixture, with very gratifying results. There is no advantage in substituting the subcarbonate for the subnitrate of bismuth in order to avoid bismuth intoxication. Either preparation is liable to produce this complication if used carelessly. Such complications should occur extremely rarely. In my own series of 1,800 cases not a single fatal case has occurred.

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SOME TECHNICAL FEATURES OF LAMINECTOMY FOR SPINAL DISEASE AND INJURY

BASED ON ONE HUNDRED AND FIFTY SPINAL OPERATIONS *

CHARLES A. ELSBERG, M.D.
NEW YORK

In our operations for spinal disease or injury, we have used different methods of approach (curved and straight incisions, hemilaminectomy and complete laminectomy) and various instruments, and I have arrived at the conclusion that the complete removal of the spinous processes and laminae is the simplest and most reliable method for the opening of the spinal canal. Complicated instruments are unnecessary. After the exposure of the spines and laminae by a straight incision and the separation of the muscles, the spines are removed at their bases with large rongeur forceps, and the laminae are bitten away with smaller rongeurs of various sizes and patterns. For the exploration of the spinal canal, a defect at least 1 cm. in width should be made, so that all sides of the cord can be investigated with the minimum amount of handling of the delicate cord tissues. If posterior roots are to be divided, the opening may be somewhat narrower than that for exploration; for decompressive purposes the opening should be at least 1.5 and usually 2 cm. in width (Figs. 1, 2 and 3).

Our experience has shown us that, unless the cord has been invaded (as in incision of the cord for the extrusion of intramedullary growths) marked exaggeration of the symptoms of a spinal disease should rarely

* From the Surgical Services of the New York Neurological Institute and Mount Sinai Hospital.

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follow a laminectomy. The exaggeration of symptoms is usually due to trauma to the cord from too much or too rough manipulation or from hemorrhage into the sac of the arachnoid. As our experience in spinal surgery increased, we found that a more than very temporary exaggeration of the symptoms for which the operation was performed became correspondingly less frequent. While all parts of the cord are very sensitive, the conus and origin of the nerves of the cauda equina are especially vulnerable, and after operations in this region, disturbances of the bladder and rectum and of the lower extremities are especially apt to occur.

DECOMPRESSIVE LAMINECTOMY

The benefits from spinal decompression in non-removable expanding lesions within the spinal canal (tumors, etc.), and in compression of the cord by diseased or dislocated bone, are fully as great as those from cerebral decompression in intracranial disease. The opening in the spinal canal should always be a wide one, so as to give plenty of space.

When a decompressive laminectomy for old or recent fracture of the spine is performed, the surgeon must be sure to take away a sufficient number of spines and laminae. To remove the arches of the fractured or dislocated vertebrae so as to relieve the compressed cord, or to allow the angulated cord to bulge backward, is not enough. It is usually necessary to take away one or two arches above and below, so that the dural sac has sufficient room to bend backward in a gradual curve. In some cases of spondylitis, in which the intervertebral foramina are diminished in size so that the spinal nerve roots are compressed, it may be necessary to enlarge some of the intervertebral foramina with small rongeurs. In one instance I was able, by this procedure, to free several nerve roots from pressure, and thus relieve the patient of a severe root pain.

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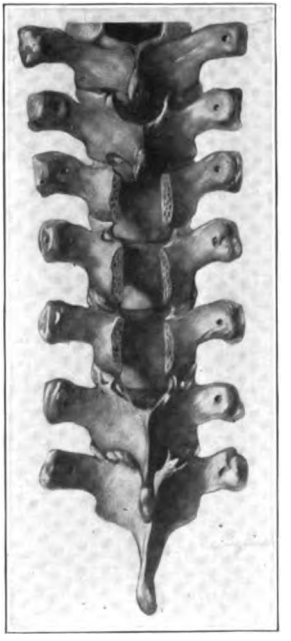

Fig. 1.—The amount of bone removed in the operation of laminectomy.

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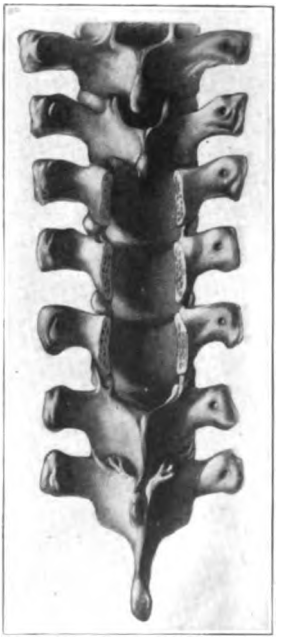

Fig. 2.—The amount of bone to be removed in a decompressive laminectomy.

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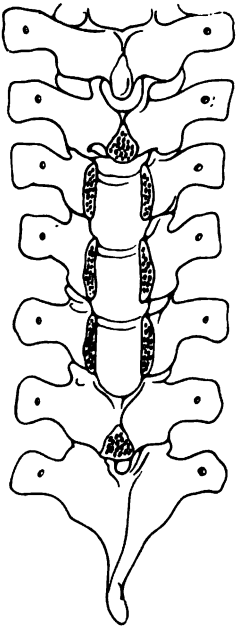

Fig. 3.—The amount of bone removed in a laminectomy, and the removal of the tips of two spinous processes.

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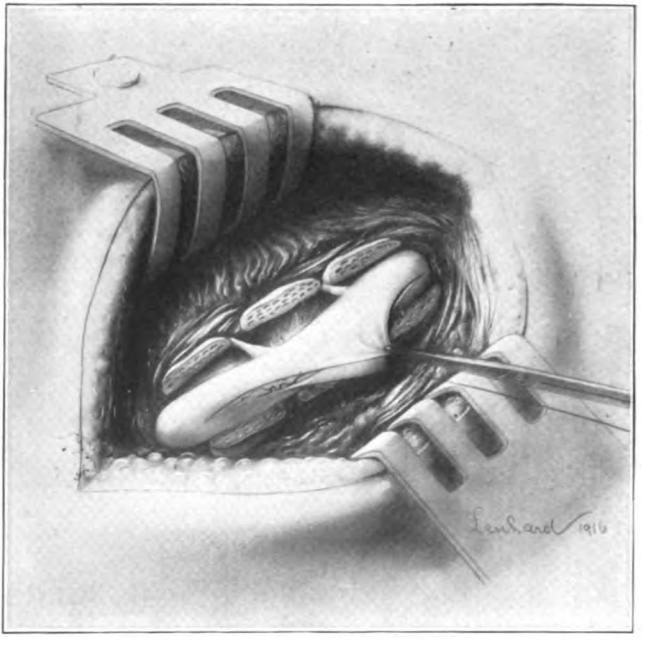

Fig. 4.—Method for the exposure of the posterior surface of the bodies of the vertebrae.

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It is often advisable to cut a few slips of the dentate ligament at the affected level of the cord, so as to give the cord a greater freedom of movement. The division of a number of slips of the dentate ligament near their attachment to the dura does absolutely no harm, and will always allow a backward dislocation of the cord. Whenever a disease on the anterior surface of the cord (such as a growth) has to be exposed, the manipulations are made more easy by the division on each side of one or two slips of the dentate ligament. When the decompressive laminectomy is performed on account of disease of the dura, it may be necessary to excise a large piece of that membrane. This excision may have to extend on both sides down to and into the dural openings. Such a wide excision of the dura may be required in cases in which the root pains have been very severe. If the disease is confined to the outer surface of the dura, it may be possible to dissect off and excise the thick outer layer of the membrane. If this cannot be done, the dura must either be incised and left wide open, or the diseased part is excised. If the dura is left open, the cord should be covered by a piece of Cargile membrane, and the muscles and fasciae should be united with extreme care.

THE NORMAL AND PATHOLOGIC APPEARANCE OF THE CORD

Considerable experience is necessary before slight abnormalities of the brain tissue can be recognized as such. The same difficulties are encountered in spinal disease; in fact, we have as yet a very limited knowledge of the intravitam macroscopic appearance of the spinal cord in a number of its diseases. I have made notes of the appearance of the cord and nerve roots in my spinal operations, and shall give an account of some of the pictures observed. The surgeon who does much spinal work should not only be able to recognize such gross abnormalities as tumors, pachymeningitis, etc., but he should also understand the finer changes that occur in spinal disease.

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THE COLOR OF THE SPINAL CORD AND NERVE ROOTS

Normally the spinal cord and nerve roots are of a creamy white color, and the vessels on the posterior surface of the cord are fairly prominent and somewhat tortuous. The spinal cord in childhood is slightly more yellow, while in advanced age, its color is a more pure white.

While slight individual variations occur, a dead white of the cord is an evidence of medullary atrophy. In multiple sclerosis, it is often possible to recognize the location of a sclerotic patch by the whiteness of the cord at the affected level. A similar pallor of the tissue can sometimes be observed at or below the level of an old injury of the cord. Below an old transverse lesion, the cord is usually of a deeper yellow tint than normally, and I have observed the same yellowish color in transverse myelitis following the puerperium and in pernicious anemia.

The white cords are often flat, shrunken and irregular in consistency. They are sometimes so thin that they float on the cerebrospinal fluid, and undergo undulatory movements with the respiratory waves of the cerebrospinal fluid.

The spinal cord may appear congested in intramedullary disease (myelitis, acute softening), in meningitis, in disease of the dura or arachnoid, below the level of an extramedullary compression, or after a trauma. It is very important for the surgeon to have a clear idea of the differences in the appearance of a congested cord due to inflammatory disease and a cord in which the veins are distended following a compression above the level exposed. The inflamed or hyperemic cord has a pink color due to the dilatation of all the vessels in the pia-arachnoid. When the cord is compressed at some higher level, however (especially in spinal tumors), the return flow in the veins is interfered with, so that the veins stand out prominently as dark, tortuous vessels on the normal white background of the cord. This engorgement of the veins has, in

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a number of exploratory operations, led me to expose more of the cord at a higher level, and I have been enabled to find and remove tumors which would otherwise have been missed. In inflammatory diseases, the nerve roots are also congested, and often bluish-red; but below the level of a compression, the nerve roots are normal in appearance.

If the roots of the cauda equina are exposed soon (within twenty-four hours) after a lumbar puncture has been performed on the patient, it is not unusual to observe that a few of the nerves are reddish-blue. The changed roots usually lie near the median line, and the discoloration is probably due to slight injury from the lumbar puncture needle. A marked congestion of all the roots of the cauda equina is an evidence of a low grade inflammatory process in the roots. This occurs in syphilitic disease of the membranes, and in a disease described by Foster Kennedy and myself and by Oppenheim, which we have described as "neuritis of the cauda equina."

THE INJURY TO THE CORD BY THE PRESSURE OF AN EXTRAMEDULLARY TUMOR; TECHNICAL DETAILS IN THE REMOVAL OF SPINAL CORD TUMORS

The amount of compression of the cord by an extramedullary new growth depends on its duration and size. Large intraspinal tumors are usually much softer than small ones. The larger, softer growths cause a more diffuse pressure on the cord, while in the small hard ones, the pressure is more concentrated. This is the explanation for the surprising fact that small tumors (on account of their consistency) are more apt to cause a complete and irremediable transverse lesion of the cord.

The amount of injury done to the spinal cord varies also with the location of the tumor. Tumors under a nerve root or under a slip of the dentate ligament are more apt to cause serious injury than growths on the posterior columns.

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If, at an operation, a new growth is found which lies under a nerve root or a slip of the dentate ligament, the root or ligamentous band should be divided before the tumor is removed. It is generally inadvisable to make the attempt to free the growth and to pull it out from underneath these structures, for in the necessary manipulations, injury to the cord is apt to occur.

Properly to expose a spinal cord tumor, the arches of at least three vertebrae must be removed. If this does not completely expose the tumor, additional spines and laminae should be taken away, and the incision in the dura extended. The new growth may be adherent to the pia or may have originated beneath the pia, and serious trauma to the cord might follow if the growth was forcibly drawn out of its bed.

If the tumor is found to be very adherent to the cord, as occurs especially in subpial growths, it is often advisable to leave a small piece of capsule behind rather than to make the attempt to free the tumor from the cord. Most spinal growths are well encapsulated, grow very slowly, are clinically benign, and have very little tendency to recur. The danger of relapse if a small piece of capsule is left behind is small, and is more than counterbalanced by the lessened danger of injury to the cord. Several patients, in my experience, in whom a small part of the tumor capsule was left behind at the operation, have remained well for many years.

Extramedullary growths on the anterior surface of the cord are rare; I have seen only one among twenty-eight cases. To remove a growth in that location without too much manipulation of the cord requires much dexterity and judgment (Fig. 4). If the growth is a small one, the division of a slip of the dentate ligament on one side may be all that is required for the rotation of the cord and the exposure of the growth. If the tumor is larger, however, the laminae on one side should be rongeured away until the approach to the anterior surface of the cord can be made without much dislocation of the cord itself.

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THE MORTALITY OF LAMINECTOMY

The accompanying table gives my operative results in 150 spinal operations for disease and injury. The total operative mortality was fifteen, or 10 per cent. If

RESULTS IN ONE HUNDRED AND FIFTY LAMINECTOMIES *

Laminectomy for:	Number of Cases	Recovered from Operation	Cured or Almost Cured	Markedly Improved †	Little or no Improvement	Died	Died Within One Year	Total
Spina bifida occulta	2	2	..	2	..	..	..	2
Abnormal spinal vessels	5	5	2	3	..	..	..	5
Recent fracture of spine	3	1	..	1	..	2	..	3
Old fracture of spine	7	7	3	4	..	..	..	7
Tumor, extradural removed	3	3	2	1	..	..	..	3
Tumor, extramedullary, removed	16	16	12	4	..	..	..	16
Tumor, intramedullary, removed	9	8	2	4	2	1	..	9
Tumor, intramedullary, not removed	8	7	..	2	5	1	3	8
Tumor of conus and cauda	5	5	..	3	2	..	2	5
Tumor, multiple sarcoma	1	1	..	..	1	..	1	1
Tumor, sarcoma of vertebrae	6	4	..	2	2	2	2	6
Tumor, metastatic	2	2	..	..	2	..	2	2
Aneurysm of spinal vessels	1	1	..	..	1	..	..	1
Exploration	15	15	..	5	7	..	3	15
Exploration, acute softening	6	...	..	..	..	6	..	6
Syringomyelia, hematomyelia	4	4	..	2	2	..	..	4
Neuritis of cauda equina	6	6	3	3	..	..	..	6
Pachymeningitis	4	4	1	3	..	..	..	4
Acute osteomyelitis	2	1	1	..	..	1	..	2
Ostearthritis	1	1	1	..	..	..	..	1
Spinal decompression	17	17	3	9	5	..	..	17
Spinal decompression, meningomyelitis	3	3	..	2	1	..	..	3
Division of posterior roots	22	21	..	15	5	1	3	22
Division of anterolateral tracts	2	1	..	1	..	1	1	2
Totals	150	135	30	66	35	15	17	150

* There were, in addition, ten secondary laminectomies.
† Many of these patients have recovered entirely.

the cases with a fatal outcome are examined, it will be found that in most of them the patients suffered from an irremediable and rapidly advancing disease. Thus, two patients died after an operation for recent frac-

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ture of the cervical spine, with complete crushing of the cord; six patients died after periods of from one day to two weeks following an exploratory operation for acute softening; two patients died after an exploratory operation for hopeless sarcomatous disease of the vertebrae; one patient succumbed after an attempt to relieve a streptococcus sepsis due to acute osteomyelitis of the vertebrae. These eleven patients were all beyond the hope of surgical relief, and the operation must be considered only as a contributing cause of the fatality.

The four other deaths occurred in patients in whom life might have been prolonged if no surgical interference had been undertaken. One patient succumbed from respiratory paralysis a few hours after the removal of a high cervical intramedullary growth. She had had respiratory and cardiac disturbances before the operation, and a quadriplegia. The second patient died two days after an exploratory operation for a high cervical intramedullary tumor, which was infiltrating and was continuous with another growth in the posterior cranial fossa. The third patient had a metastatic growth of the ribs after the removal of carcinoma of the colon, and died three days after laminectomy and posterior root section done to relieve a distressing root pain. The fourth patient, finally, died from an acute ascending paralysis after the division of the anterolateral tracts for pain.

In order to obtain a fair idea of the dangers of a laminectomy in remediable diseases the eleven fatal cases in Group 1 can be fairly excluded as cases of hopeless and surely fatal disease. And a scrutiny of the four cases in Group 2 will show that several of the patients suffered from hopeless disease which would of itself have terminated their lives in a short time. If the cases of Group 1 were excluded, I should have had 139 operations with four deaths, or a mortality of 2.9 per cent. I believe that this is about the mortality that

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the operation of laminectomy should have in individuals who have not a spinal disease which will be rapidly fatal without operative interference.

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ABSTRACT OF DISCUSSION

Dr. E. Sachs, St. Louis: The approach to the anterior surface of the spinal cord has always been a difficult problem on account of the important factor that one must not handle central nervous tissue any more than necessary and putting in the retractor to draw the cord to one side is a very dangerous procedure. Dr. Elsberg has pointed out that the different circulatory disturbances apparent as soon as the cord is exposed are of great diagnostic value in determining the character of the pathologic lesion. I am inclined to differ from him in one point, that is, that the congestion of the veins when the dura is opened is an evidence of a lesion higher up. The mere opening of the dura and changing the intraspinal pressure is sufficient to produce congestion of the veins. Dr. Elsberg emphasized also the importance of a dry field. Nothing gives more postoperative trouble after laminectomy than allowing blood to get into the spinal canal. It has been my practice never to open the dura until the field is entirely dry. Then, in order to prevent any blood from getting in from the muscles on either side I make use of Frazier's method, putting in sponges on either side to exclude the muscles as well as the skin from the operative field so that nothing is exposed except the dura and the cord. I have never found it necessary to use a suction apparatus such as Dr. Elsberg illustrates. No doubt it might be of very great value. After the incision has reached the spinous processes he makes an incision through the muscles. That is the cause of considerable hemorrhage. I try never to cut the muscles and stick closely to the bone and peel back the periosteum, starting at the tips of the spinous processes. In that way you can get a very much drier field. His point about taking off a large amount of bone and a great many spinous processes, if necessary, I endorse heartily. As he said, the spinous processes in no way support the spinal column and five or six or seven spinous processes can be removed with impunity and the mobility of the back be as good as prior to that time. The method of hemilaminectomy, which Dr. Taylor of New York has used so extensively, has not been of any advantage in my hands. His emphasis of cutting the posterior roots in order to get more exposure for a tumor rather than trying to get a tumor out through a narrow opening is a method that should be used whenever necessary. Any method that will avoid trauma to the

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nervous tissue is to be recommended even though you may produce a small zone of anesthesia after cutting a posterior root.

Dr. Charles Albert Elsberg, New York: After the tips of the spines have been exposed, I formerly used the periosteal elevators to separate the periosteum from the spinous processes, but found that one did much more injury to the muscles than if they were separated by cutting close to the spines. With reference to congestion of the veins when the spinal cord is exposed: It is very true that within fifteen or twenty minutes, if the cord is exposed for that length of time, there is a reflex enlargement of the spinal veins; but the appearance in the conditions I demonstrated is entirely different. The moment one sees these large veins they mean obstruction to the return venous flow and compression of the cord above the level exposed. I am quite sure this enlargement is not reflex; it is a real pathologic condition which has significance and which has in a number of instances led us to look for and remove tumors which otherwise would not have been found.

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BRACHIAL PLEXUS SURGERY

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The present European war, with its colossal total of wounds, many of which inevitably involve the peripheral nerves, has aroused an added interest and stimulated additional research in the surgery of this system.

Brachial plexus injuries in the adult, aside from those resulting from gunshot or stab wounds, or secondary to skeletal injuries, are rare, as was shown in 1911 by Frazier and Skillern,[1] who were able to collect reports of only twenty-one cases which had been verified by operation. Anatomically the brachial plexus, located almost subcutaneously in the root of the neck and unprotected by the skeleton, is vulnerable to direct injury. Direct trauma used to be considered the most frequent cause of injury to these nerves until experimentation by Horsley[2] and Taylor,[3] and a closer study of etiologic mechanics convinced observers that injury of the plexus did not frequently result from pinching them between the clavicle and first rib, but rather from their forcible avulsion, which tore the cords out by the roots, in the intravertebral and intervertebral cases, and ruptured them anywhere between the spine and axilla in the supraclavicular or infraclavicular types.

The relatively large number of so-called cases of "birth palsies" in infants, which at present are being

1. Frazier, C. H., and Skillern, P. G.: Supraclavicular Subcutaneous Lesions of the Brachial Plexus Not Associated with Skeletal Injuries, The Journal A. M. A., Dec. 16, 1911, p. 1957.
2. Horsley, Sir Victor: Practitioner, London, 1899, lxiii, 136.
3. Taylor, R. W.: Med. News, 1905, lxxxvi, 1013.

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reported, lend confirmatory evidence that avulsion of the brachial plexus trunks comes from indirect violence, for here the upper cords of the plexus are torn asunder or out of the foramina themselves, by extreme traction of the shoulder away from the head in the birth of the child. When the lower cords are injured, this results from breech presentations in which the arm is stretched up over the shoulder and the lower cords are put severely on the stretch, probably over the head of the humerus. Again, there are the reported cases in adults when heavy objects like trees or timbers fall on the shoulder and pull it away from the neck, as in Murphy's case;[4] or when men are thrown onto their shoulders, violently separating the neck from the shoulder as in Peck's case;[5] or in falling from a height and clutching at something to break their fall, their arm is violently abducted and pulled above the head, as reported by Brislow;[6] or, as happened in both of my cases, the patient's arms are caught in belts and they are pulled into and whipped forcibly over pulleys, the arms being jerked away from the bodies, and in one instance the man being thrown heavily against a post, striking on the root of his neck. All of this accumulated evidence disproves the theory of direct violence.

Successful surgery of the brachial plexus, as of any of the peripheral nerves, is dependent on the application of our present day relatively exact knowledge of the phenomena of regeneration in the peripheral segments of severed spinal nerves, which occurs when that segment is united to the viable central segment, and furthermore on an appreciation of the property which nonmedullated neuraxons have of projecting themselves through space and reaching across a gap separating the severed nerve stumps, when properly guided and conducted by some method of tubulization,

4. Murphy, J. B.: Surgical Clinics, 1912, i, 339.
5. Peck: Ann. Surg., 1911, liii, 858.
6. Brislow, A. F.: Ann. Surg., 1902, xxxvi, 411.

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preferably of fascia, as in my[7] case in which the musculospiral nerve completely regenerated across a space of 3 inches through a fascia lata tube. Lewis'[8] recently reported observations as to how the non-medulated neuraxons are conducted by and follow protoplasmic bands, which span this gap and originate from both stumps, is added evidence which opens up a fascinating realm of surgical opportunity and offers relief in the class of cases which have heretofore been considered hopeless.

After the severance of a nerve, both stumps undergo neuromatous degeneration, and scar tissue infiltrates the retracted clubbed ends and for a greater or less distance invades the nerve trunks. Serial sections of these clubbed ends ultimately expose the brush ends of the nerve fibers. If, then, these exposed and cleanly cut across fibers are approximated end to end and protected from the ingrowth of connective tissue by wrapping the union with a fascial or fat flap, we expect complete regeneration of the peripheral nerve, provided the central ganglionic cells are intact.

It is illuminating to know that it is entirely possible to make one highly specialized motor nerve carry impulses to a paralyzed group of muscles served by another injured or degenerated nerve, provided the paralyzed peripheral nerve segment is anastomosed with the proximal segment of the healthy nerve. This restoration of function is possible through a reeducation of the cortical centers (adjacent to or remote from one another) which enables them to meet the needs and respond to the peripheral necessity. Much research by many observers has clinched the conviction that this reeducation is entirely feasible, as is shown in the observations of Flourens[9] on the crossed anastomosis of the brachial plexus in cocks, those of Rawa[10] on cats,

7. Law, A. A.: Some Modern Phases of Neural Surgery, St. Paul Med. Jour., September, 1915.
8. Lewis, Dean: Tr. Am. Surg. Assn., May 9, 1916.
9. Flourens: Recherches expérimentales sur les fonctions du système nerveux, 1824, p. 272.
10. Rawa: Arch. f. Physiol., 1864, p. 421.

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and of Kennedy[11] and Murphy[12] on dogs, most of these observers reporting practically perfect results. Schiff[13] crossed the hypoglossal and vagus nerves and found return of motion in the muscles of the tongue. In the experimental surgical laboratory of the University of Minnesota, Dr. Corbett and I cross anastomosed the various nerves of the brachial plexus in five dogs, wrapping the line of union with fascial flaps or vein cuffs. So perfect was the reeducation that at the end of five months it was difficult to determine which side had been operated on.

The clinical application of these laboratory findings has yielded excellent results, as demonstrated by the spinofacial and spinohypoglossal anastomoses, as originally suggested by Ballance and Stewart,[14] and carried out so successfully by Cushing[15] and other surgeons. Here restoration of function of the muscles of facial expression is more or less perfectly accomplished by reeducation of the brain centers; until that occurs and sometimes permanently, associated movements of the shoulder and face or of the face and tongue persist. Grant's[16] remarkable result following spinofacial anastomosis, with the attendant anastomosis of the distal accessory fragment to the descendens hypoglossi, opened a new field of endeavor, for here the motor nerves arising from the first and second cervicals and running in the sheath of the hypoglossal, with their centers, were reeducated to control the trapezius and do away with associated shoulder and face movements.

The success of these anastomoses and the reported success of the anastomosis between the anterior tibial and musculocutaneous nerves by Spiller and Frazier[17]

11. Kennedy, Robert: Phil. Tr. Roy. Soc. London, 1901, Series B, cxciv, 127.
12. Murphy, J. B.: Surg., Gynec. and Obst., 1907, iv, 454.
13. Schiff: Arch. d. sc. phys. et nat., Geneva, 1885.
14. Ballance and Stewart: Brit. Med. Jour., May, 1903.
15. Cushing, Harvey: Ann. Surg., May, 1903.
16. Grant, W. W.: Traumatic Facial Paralysis, The Journal A. M. A., Oct. 22, 1910, p. 1438.
17. Spiller, W. G., and Frazier, C. H.: The Treatment of Acute Anterior Poliomyelitis by Nerve Transplantation, The Journal A. M. A., Jan. 21, 1905, p. 169.

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and Young,[18] and between the external and internal popliteal by Murphy[19] and Kader[20] in cases of infantile paralysis, give more than enough evidence to warrant the expectation of more or less perfect restoration of function, whether the nerves crossed be a part of the brachial or lumbar plexus or any of the peripheral nerves of highly specialized function.

Nerves which are forcibly avulsed are injured in a vastly different manner than those which are deliberately or accidentally cut cleanly across by a sharp instrument. In the avulsed trunks the bundles of neuraxons are torn at different levels and are frayed and pulled apart and severely traumatized, the endoneural blood vessels are torn, hemorrhage occurs in the sheath, and this with the trauma of the accident and the hemorrhage about the nerves results in the secondary formation of scar tissue, either in the nerve sheaths themselves or about them. Later, scar contraction results in multiple neuromatous nodules of the trunks, which prevents the projection of the proximal axones into the distal segments, or the contraction of the perineural connective tissue strangulates the fibers to the extent of partially or wholly interfering with conduction, which inevitably is followed by trophic changes and motor and sensory paralysis.

One type of injury or neuritis which has been thoroughly studied by surgeons and neurologists is that caused by pressure on the lower cords of the brachial plexus by supernumerary ribs. This results in a pinching of the nerves in the angle formed by the scalenus anticus muscle and the cervical rib, this pinching being accentuated by the constant hammering from respiratory movements. A phase of this type of injury which seems to have escaped attention is caused, not by an adventitious rib, but by a supernumerary band or ligament taking the place of the rib and springing from the

18. Young, J. K.: Internat. Clin., lv, Series 14, p. 154.
19. Murphy, J. B.: Surg., Gynec. and Obst., 1907, iv, 470.
20. Kader: Chipaults état actuel de la chirurgie nerveuse, ii, 202.

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seventh cervical transverse process, projected forward and inserted either into the first rib with the scalenus anticus, as occurred in one of my cases, or into the interclavicular ligament, as happened in the other.

In both of my cases at operation, accessory ribs were absent. The seventh cervical transverse processes, however, seemed in the roentgenograms to be drawn down closer to the first dorsal transverse process on the affected side. In both instances these ligaments were extremely taut, and tightly stretched over them and sharply angulated were the eighth cervical and first dorsal cords of the brachial plexus, the tension on which was immediately relieved when the ligaments were cut. This condition gave the typical peripheral symptoms in the hand, which are so characteristic of cervical ribs and the coincident brachial neuritis. In one of these cases, the trophic changes in the phalanges of the middle finger on the affected side were interesting to note. Comparative roentgenograms of both hands showed marked rarefaction of these bones, which was apparently identical with the picture of disuse atrophy.

Symptoms of brachial plexus injury or rupture are of course dependent on where the cords are injured. In the upper arm or "Erb-Duchenne" type, this injury generally occurs to the fifth and sixth branches proximal to the origin of the suprascapular nerve, and therefore the supraspinatus and infraspinatus are paralyzed. The characteristic atrophy of these muscles occurs along with inward rotation of the shoulder and arm until the hand and forearm is in extreme pronation. Winging of the scapula when the arm is held horizontal and pushed on is shown when the injury is high enough to be above the origin of the long thoracic nerve, and is caused by paralysis of the serratus magnus muscle. Coincident with the paralysis of the shoulder girdle may be paralysis over the distribution of the posterior cord arising from the seventh cervical with branches from the fifth and sixth. Here, of

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course, the deltoid, biceps, coracobrachialis, triceps, brachialis anticus, supinators of the forearm and extensors of the wrist and fingers may be involved.

In the "Klumpke" or lower arm type, the eighth cervical and first dorsal branches are involved, and the symptoms are manifested in the areas supplied by the median ulnar, cutaneous and lesser internal cutaneous nerves, while the enervation to the upper arm and shoulder may be intact. This type is more uncommon than the former, and is liable to be accompanied by injury to the sympathetic system owing to loss of the celiospinal fibers which join it, coming from the first and second dorsal nerves and occasionally from the eighth cervical.

Injury to these fibers results in a typical series of symptoms, namely, narrowing of the palpebral fissure, or pseudoptosis, from paralysis of the nonstriated muscle fibers of Muller[21] in the upper lid, and enophthalmos, or sinking of the eye from paralysis of the nonstriated microscopic muscle fibers, described by Landstrom,[22] which are found in the fascia behind the eyeball and attached to the capsule of Tenon: also a contraction of the pupil on that side due to predominance of the motor oculus. Anhidrosis of this side of the face and neck may be observed from loss of sympathetic control of the sweat glands. These symptoms are generally an indication of an intradural avulsion.

In the cases in which all the cords have been avulsed high within the dura or foramina, the persistence of sensation on the inner side of the upper arm is explained by the loops of communication between the nerves of Wrisberg and the intercostohumerals with the first, second and third intercostal nerves, which cannot be injured by avulsion.

In addition to the twenty-one cases of avulsion in adults verified by operation and collected up to 1911, we have found two other cases reported by Hartwell[23]

21. Muller: Ztschr. f. Zool., 1858; Worzb. Verhandl., 1859.
22. Landstrom: Ueber Morbus Basedowii, 1907.
23. Hartwell, J. A.: Ann. Surg., 1914, lx, 516.

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and Murphy.[4] These with my own two cases with operation swell the total to twenty-five. These injuries in adults are so rare that it is not given to any one surgeon to see a large series. Therefore I am constrained to report my cases somewhat in detail:

REPORT OF CASES

CASE 1.—G. H., man, aged 23, Dec. 5, 1914, while working in a flour mill, got his left arm caught in a large belt which picked him up and whipped him over a pulley before he was thrown off. This injury resulted in an immediate paralysis of all extensors of fingers and wrist, and of the supinators and the triceps. The biceps, coracobrachialis and brachialis anticus were paralyzed as well. Anesthesia existed on the anterior and posterior aspects of the upper arm from the middle of the deltoid to and including the elbow and over all of the forearm and hand, save on the ulnar side of the hand from the midline of the ring finger, front and back, and extending up to the wrist. There was sensation over the first phalanges of the first, second and third fingers on the dorsum. There was sensation on the inner side of the upper arm, beginning 2 inches above the elbow. The shoulder girdle was intact with the exception of the deltoid, which was paralyzed. This injury, then, was of the mixed type, and obviously involved the musculocutaneous below the outer head of the median, and the musculospiral above the origin of the circumflex.

There were no symptoms of sympathetic involvement, and all the muscles involved showed the reaction of degeneration prior to operation. April 29, 1915, or four and one-half months after the injury, the clavicle was sawed in two and an anatomic dissection of the brachial plexus made. This revealed a tortuous neuromatous scar of the musculocutaneous nerve, beginning just distal to the outer head of the median. The proximal stump of the musculospiral could not be recognized, and the distal stump was clubbed and retracted 3 inches from its normal origin. All other cords and their branches, save the musculocutaneous and musculospiral, responded normally to a faradic exciter. The neuroma of the musculocutaneous was resected by serial sections for 3 cm. until the normal fasciculi of both stumps were determined, when the stumps were approximated with fine chromic gut sutures. The line of union was then wrapped with a pedicled fascial flap from the stump of the pectoralis major. The clubbed distal end of the musculospiral was resected and this nerve implanted by end-to-side anastomosis into a slit in the side of the median nerve and anchored there with chromic gut, the line of union being wrapped with a pedicled flap of axillary fat. The sectioned clavicle was drilled and united with kangaroo tendon.

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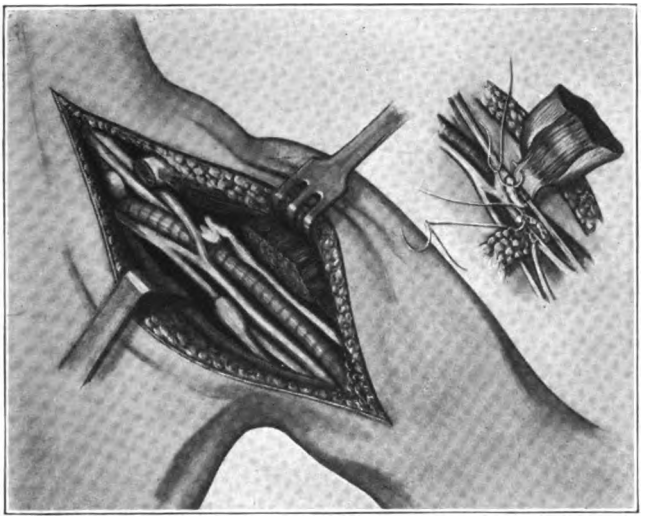

Fig. 1 (Case 1).—Avulsion of musculocutaneous and musculospiral nerves. Inset shows end-to-end and end-to-side or crossed anastomosis.

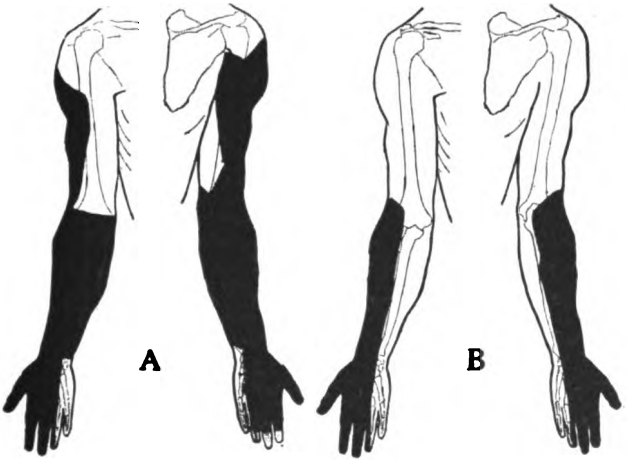

Fig. 2 (Case 1).—Dark areas indicate extent of anesthesia A, before operation, and *B*, thirteen months later.

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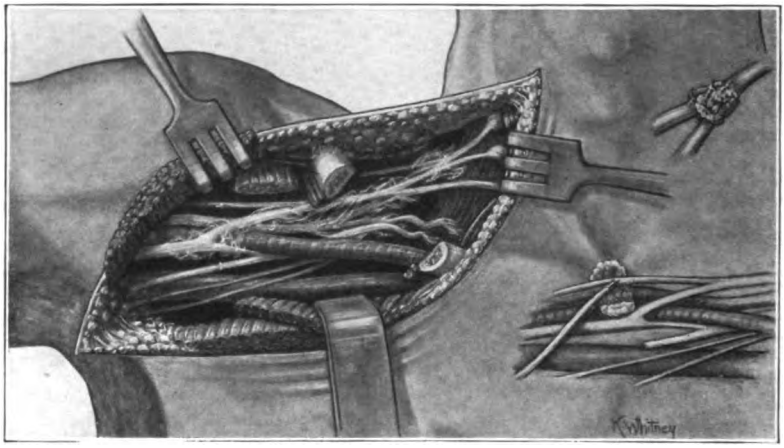

Fig. 3 (Case 2).—Avulsed nerves of brachial plexus, neuromatous nodules and scar tissue about plexus. Insets show transposition, suture and wrapping of the line of union with free fascial flaps.

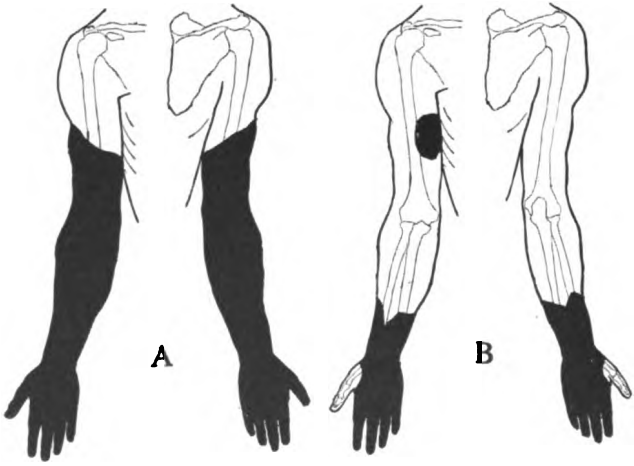

Fig. 4 (Case 2).—Dark areas indicate anesthesia: *A*, before operation, and *B*, four months later.

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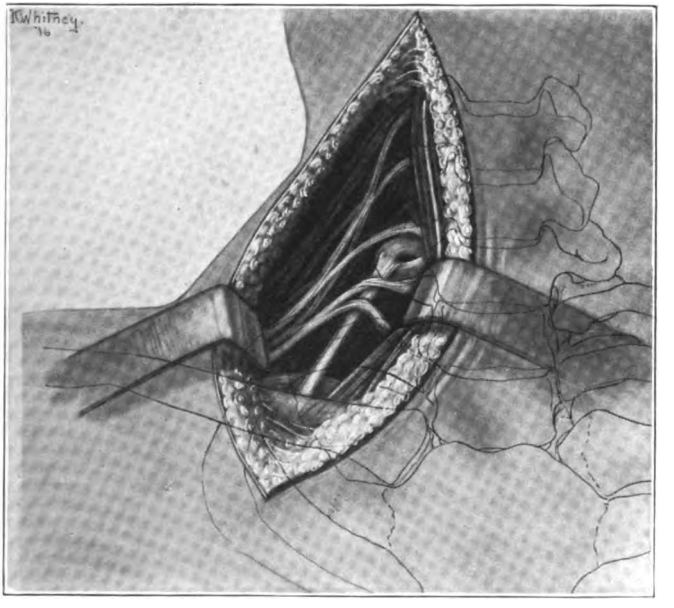

Fig. 5 (Case 3).—Adventitious ligament taking the place of a cervical rib; brachial plexus stretched over it.

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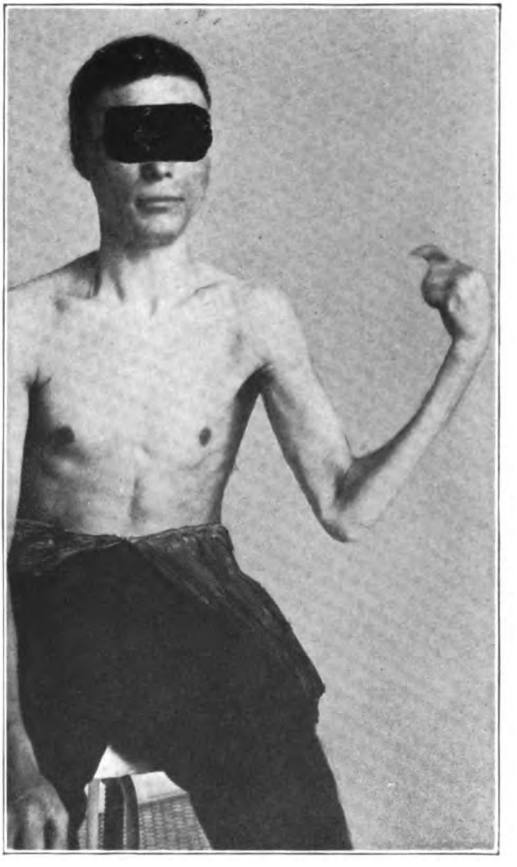

Fig. 6 (Case 1).—Restoration of function by reeducation, thirteen months after operation.

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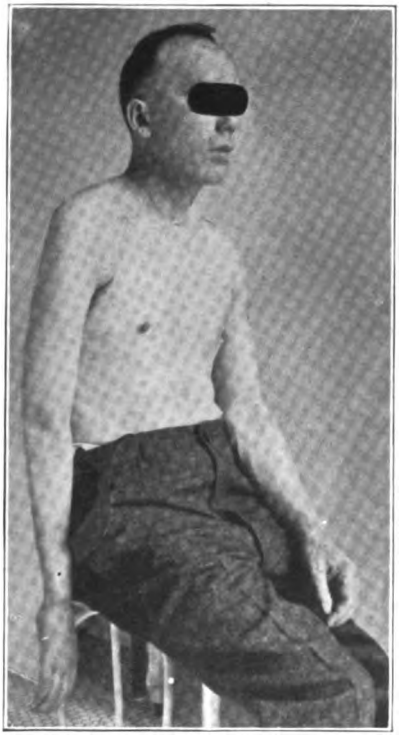

Fig. 7 (Case 2).—Internal rotation of arm from paralysis of the shoulder girdle.

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Now, thirteen months later, by reeducation, this man has nearly a normal return of all of the functions of the deltoid, coracobrachialis, biceps, brachialis anticus and triceps; he can extend, supinate and pronate the forearm fairly well, flex the wrist very well, and he flexes the second, third and fourth fingers well, the index finger very slightly, and the thumb not at all. The wrist extensors are but feebly functionating, and those of the thumb and index fingers not at all. Those of the last three fingers show about 75 per cent. of function. Sensation has returned save over the radial half of the forearm and hand, or corresponding to the distribution of the muscle spiral, musculocutaneous and radial nerves. The trophic changes in the limb show a marked improvement, save in the thumb and index finger. From an arm that was worthless this man now has a limb which, although it is far from normal, is extremely useful, and which in view of the fact that it frequently takes many months or even years completely to regenerate and reeducate nerves, gives promise of still further improvement. Should the function of extension of the wrist not return, we shall ultimately transplant the tendon of the flexor carpi radialis into the common extensor tendons.

Case 2.—A. W., man, aged 42, Dec. 23, 1913, while working in the flour mills, had his right arm caught between a belt and pulley, and he was thrown violently, striking a post with the root of his neck. There was immediate paralysis of his entire right arm and shoulder girdle, together with right sided enophthalmos, pseudoptosis and contracted pupil, indicating involvement of the sympathetic or ciliospinal fibers. The trapezius, levator anguli scapulae and rhomboidei were functionating: the serratus was paralyzed, but the pectorals were feebly acting. Sensation was lost from 3 inches below the axilla.

From these observations we concluded that all the cords of the brachial plexus were involved and that the lesions were high up, as the suprascapular and long thoracic nerves were injured, as were the sympathetic fibers in the eighth cervical and first dorsal roots.

At operation, Feb. 1, 1916, after the splitting of the clavicle, an anatomic dissection of the brachial plexus was made, and revealed that all of the cords were bound down by scar tissue near the middle of the plexus, that the first and second cords just after they emerged from the foramina showed definite neuromatous nodular enlargements, and that the eighth cervical and first dorsal nerves were buckled on themselves and relaxed, although they still were adherent by connective tissue to the foramina.

After all scar tissue about the plexus was dissected off, faradic stimulation of the various cords revealed a slight response from the muscles supplied by the suprascapular and musculocutaneous nerves, slight from the musculospiral and

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median but none at all from the ulnar nerve. Apparently the roots of the eighth cervical and first dorsal were torn off the cord, while all the other nerves had conduction interfered with by scar tissue either within or without the sheaths. The ulnar nerve was sectioned high, and by the end-to-side method united to a notch in the musculocutaneous, that being the trunk giving the greatest faradic response, and the line of union was wrapped with a free fascial flap. The entire brachial plexus was then covered by a pedicled flap of axillary fat to prevent reformation of scar tissue. Now, four and one-half months later, the trophic improvement in the limb is marked, sensation has returned in the arm and forearm down to within 2 inches of the wrist, and there is also sensation in the thumb.

There is slight voluntary action of the biceps, triceps and deltoid muscles, and there is feeble extension of the wrist. This man's injury was so high and so extensive that there is no certainty of great improvement; yet the amount of regeneration to date is significant.

CONCLUSIONS

While none of the reported cases of avulsion in the adult in which operation was performed showed complete recovery, still enough function was regained to justify interference. Such interference should include nerve transposition when indicated, our warrant being the clinical and experimental evidence, which has proved the certainty of reeducation.

420 Syndicate Building.

ABSTRACT OF DISCUSSION

Dr. Dean D. Lewis, Chicago: Surgery dealing with injuries of the peripheral nerves has been far from satisfactory. If we look over statistics dealing with a large number of cases of peripheral nerve suture we will be surprised to find that only about 36 per cent. of them can be regarded as distinct successes. It is also surprising to find that secondary nerve suture gives about the same results as primary. I believe that failure in peripheral nerve suture is often due to the fear of removing a sufficient length of the nerve to get well beyond the scar tissue, so that healthy axis cylinders are exposed which is essential to success. Studies on peripheral nerve regeneration have shown the marked ability of the fibers to regenerate. Regeneration of the axis cylinders is preceded by protoplasmic band formation which takes place from both ends of the divided nerves. These bands form conducting paths for the developing axis cylinders. I

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believe that fascia is the best material for tubulizing divided nerves. In some experimental work which Dr. Kirk and I did, we found that fascia is better than blood vessels for this purpose. The developing axis cylinders readily invade the serum in such a tube and the use of agar, as recently suggested by Edinger, does not seem necessary. An autotransplant gives the best results, as determined by histologic studies, and the method of nerve transference recently suggested by Hofmeister seems to be a distinct advance in this class of work. Dr. Law is to be congratulated on the results he has had in these two cases because the technic required in dealing with injuries of the brachial plexus is difficult, and consequently the functional results are often disappointing.

Dr. Arthur A. Law, Minneapolis: We did some experiments at the University of Minnesota to disprove the theory of positive neurotropism that Forsman brought out. It did not seem like good pathology. In a series of animals we sectioned the musculospiral nerve and avulsed the distal segments so they could exert no attraction for the proximal segment. We then inserted the proximal nerves into little fascial bags and stitched them there. We found that this little fascial sac ultimately was filled with nerve fibers, notwithstanding that they lacked the influence of chemotropism of the distal fragments.

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OPERATIVE TREATMENT FOR THREATENED GANGRENE OF THE FOOT

WITH SPECIAL REFERENCE TO REVERSAL OF THE CIRCULATION

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Threatened or slow gangrene of the foot follows a diminution of the caliber of the blood vessels supplying the foot. This results from a disease which may be clearly systemic or which may manifest itself chiefly in the blood vessels of the lower extremities. Sudden occlusions, as by emboli, with consequent rapid gangrene, do not come under the title of this paper.

The diseases of the vessels which cause slow or threatened gangrene of the foot may be divided into four groups:

1. *Arteriosclerosis.*—This condition is caused by toxic products which may come from deranged metabolism, as in nephritis; from infectious diseases, as syphilis, or from general wear and tear, as in old age. It is found chiefly in the arteries. There is excessive thickening of the media or intima or of both.

2. *Intermittent Claudication.*—This disease was described by Charcot and occurs in the legs. It consists of a vasoconstrictor spasm in arteries that are already affected with arteriosclerosis. The spasm appears on exertion, when the tissues require an increase of blood, and causes painful cramps. During the cramps the legs are cold and pale or mottled. After rest the cramps may disappear, but pulsation of the tibial arteries is feeble or lacking.

3. *Raynaud's Disease.*—In this disease there is no organic pathologic condition, but the constriction of

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vessels is due to intense spasm of the small arterioles or venules just before they become capillaries. It may be of three types, a spasm of the arterioles alone, causing a bluish color; of the venules alone, making the affected parts red, or of both the arterioles and venules, causing a blanching. Any of these types may result in gangrene.

4. *Thrombo-Angiitis Obliterans.*—Leo Buerger of New York has made a careful study of this disease, which was formerly rather vaguely classified and was referred to clinically under various terms. The German writers considered it an obliterating endarteritis. Buerger has shown that thrombo-angiitis obliterans has many distinctive characteristics and that the occlusion of the vessels is not caused by a thickening of the intima, but by a thrombosis.[1] This disease occurs chiefly in the blood vessels of the lower extremity, though occasionally the upper extremity is affected. It begins, not in the arterioles or in the smallest arteries, but in vessels of medium size, and then ascends. In the foot it is usual, according to Buerger, for the dorsalis pedis and plantar arteries to be involved first, and later the disease ascends to the tibials and sometimes to the popliteal artery. The deep veins are affected in about 40 per cent. of the cases. Occasionally a segment of apparently healthy blood vessel is found between diseased portions of the same vessel. Buerger has demonstrated that in the first stage of the disease the affected vessel shows signs of inflammatory change, and he seems to have proved quite clearly that thrombo-angiitis obliterans is due to some microbe or to a toxic material which, however, has not yet been isolated.

In the first stage there is a round cell infiltration of the media and adventitia of the vessel and usually of the tissue around the vessel. Soon after this, and sometimes almost accompanying it, a red clot forms in

1. Buerger: Am. Jour. Med. Sc., October, 1908, p. 567; ibid., February, 1915, p. 210; Surg., Gynec. and Obst., November, 1914, p. 582; Jour. Med. Research, November, 1914, p. 181; Arch. Diagnosis, October, 1915.

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the vessel and practically always obliterates it. Then small foci appear in the clot, which Buerger refers to as "miliary abscesses." They are collections of pus cells and leukocytes that form in the thrombus, usually around its periphery. The leukocytes apparently come in from the media. Angioblasts then grow into the clot and the ordinary process of organization and canalization occurs in the thrombus as elsewhere in the body except in these small foci. Here the angioblasts seem to lose their power of producing blood vessels and terminate around the edge of these pus foci as endothelial cells or penetrate the foci and either fray out or produce giant cells. A little later the giant cells arrange themselves around the periphery of the focus, the leukocytes disintegrate, and the resemblance to a tubercle is marked. After this the degenerated products are absorbed and the focus becomes connective tissue. Then all traces of acute inflammatory process disappear. The leukocytes and wandering cells in the media and adventitia and perivascular tissue disappear and the obliterated or canalized vessel is left as the final product.

This is the life history of the disease as traced by Buerger. It begins with every evidence of acute inflammatory reaction, is followed by an apparently specific process in the tubercle-like formation, and ends in organization and canalization of the thrombus. The disease is sometimes extensive and often ends abruptly in a clot which projects into the lumen of a vessel that appears to be normal. It may progress in stages, so that, while the vessels in the foot may show the old type of organized and canalized thrombus, farther up in the leg the tubercle stage may be seen, and still farther in the upper tibials the acute inflammatory reaction with a red clot, pus foci, and infiltration of the blood vessel wall and perivascular tissue may appear.

Thrombo-angiitis obliterans occurs between the ages of 20 and 35 and rarely after 40. It is found chiefly in males. Most of the patients are Russian Jews, or

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descendants of Russian Jews, or Jews from the country around Poland, the eastern part of Austria-Hungary or eastern Germany. Koga, however, has found this disease among the Japanese, and the patient whose case is reported in this paper had no Jewish ancestry and was born and raised in Virginia. The symptoms depend largely on the extent of the disease. Buerger has found that the superficial veins are often involved and may give no symptoms in themselves. There may be vasomotor symptoms such as flushing of the leg or foot when it hangs down, followed by blanching when it is elevated. Ordinarily the foot is cold and of a dark bluish or purplish color. Often pain in the calf of the leg is severe and is more marked after exertion. These symptoms may be attributed partly to the mechanical occlusion of the vessels which produces ischemia, and partly to the fact that nerves are sometimes pressed on or irritated by the scar tissue which may result from the inflammatory reaction in the perivascular tissues.

The treatment of threatened gangrene should embrace such constitutional measures as may be indicated. When the arterial disease is due to diabetes, the Allen treatment should be instituted. If from other causes, such as syphilis, appropriate remedies should be given. Locally, conservative measures as hot applications or hot air, particularly in cases of diabetic gangrene, sometimes accomplish much. De Witt Stetten[2] reports excellent results in a series of cases of diabetic gangrene which he treated along these lines, never doing a radical amputation, but merely cutting away the gangrenous tissues at the line of demarcation.

For the treatment of gangrene due to thromboangiitis obliterans, a number of remedies have been suggested, some of them quite different. Thus, Ochsner[3] believes that his patients with this disease ate

2. Stetten, De Witt: The Conservative Treatment of Diabetic Gangrene of the Lower Extremity, The Journal A. M. A., April 12, 1913, p. 1126.
3. Ochsner: Surg., Gynec. and Obst., October, 1915, p. 536.

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too much salted meat, while Koga[4] recommends hypodermoclysis with saline or Ringer's solution as a remedy. Willy Meyer[5] has obtained excellent results by the latter treatment, and thinks that the benefit is due to the fact that the solution in some way alters the quality of the blood. He has used it in more than thirty patients, and gives twenty-four injections in each case. Five hundred c.c. of Ringer's solution are given each time. Four regions of the body that take up the solution most readily are chosen and the solution is injected in these regions in rotation. The injections are given every day or every second or third day, according to the amount of discomfort that is caused.

Dr. L. L. McArthur[6] reports six cases of thromboangiitis obliterans which he has recently treated with hypodermoclysis of Locke's or Ringer's solution with gratifying results. Dr. A. J. Ochsner,[7] in discussing this group of cases, has found that patients suffering from this disease are promptly relieved from pain after an injection of Ringer's solution.

Since in all of these diseases the arteries or arterioles are chiefly affected, it has been proposed, largely as a result of the experiments of Carrel and Guthrie,[8] that the veins be utilized to carry the nutritive arterial blood to the tissues. To accomplish this, the arterial current has been switched into a vein by means either of an end-to-end or a lateral anastomosis between the femoral artery and the femoral vein. This operation has been performed by a number of excellent surgeons, Wieting having probably done more than any one else to bring it into prominence.

In order to determine whether arterial blood, when switched into the veins, really reached the tissues for which it was intended, I undertook a series of experiments on dogs about three years ago. The femoral

4. Koga: Deutsch. Ztschr. f. Chir., cxxi, 371.
5. Meyer, Willy: Ann. Surg., March, 1916, p. 292.
6. McArthur, L. L.: Surg., Gynec. and Obst., May, 1916, p. 625.
7. Ochsner, A. J.: Surg., Gynec. and Obst., May, 1916, p. 626.
8. Carrel and Guthrie: Ann. Surg., February, 1906, p. 203.

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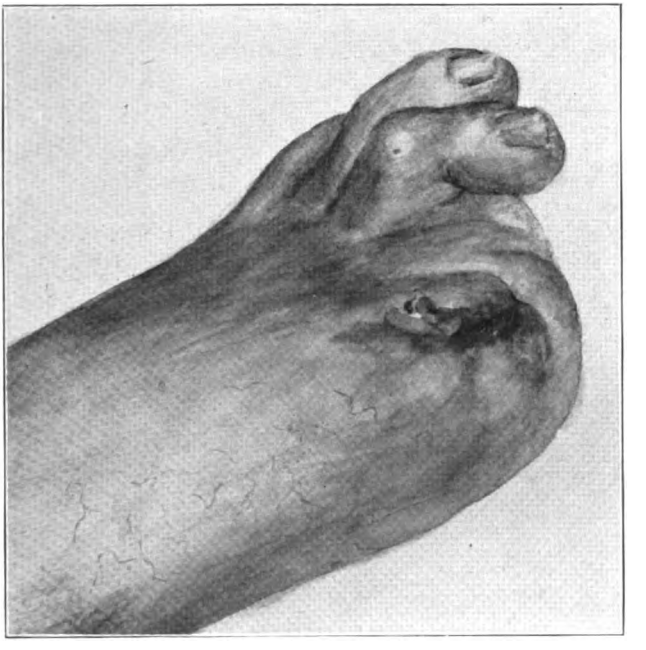

Fig. 1.—Foot before operation. The discoloration started at the stump of the great toe.

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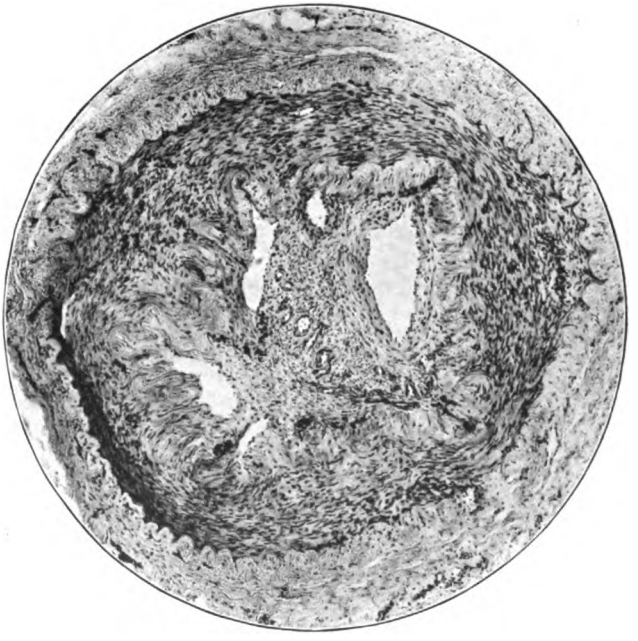

Fig. 2.—Photomicrograph showing old lesion of thrombo-angiitis obliterans in the posterior tibial artery. From a case of Dr. Leo Buerger, who kindly lent me the photomicrograph.

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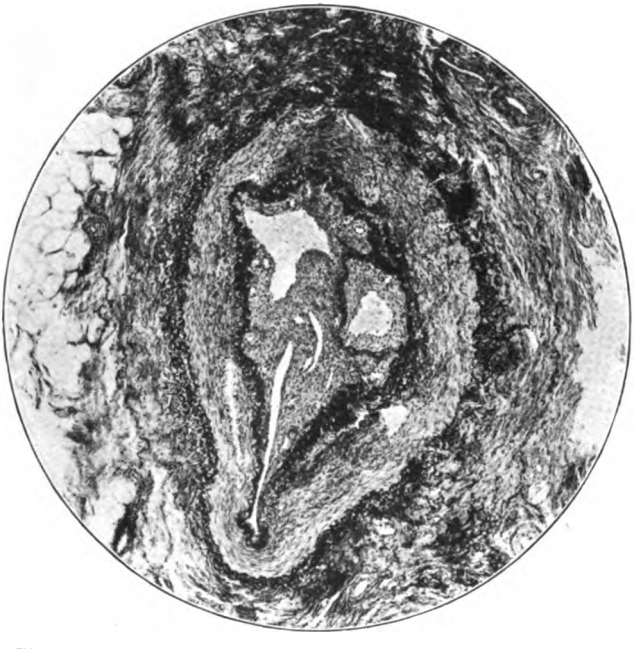

Fig. 3.—Another photomicrograph from a case of thrombo-angiitis obliterans of Dr. Buerger.

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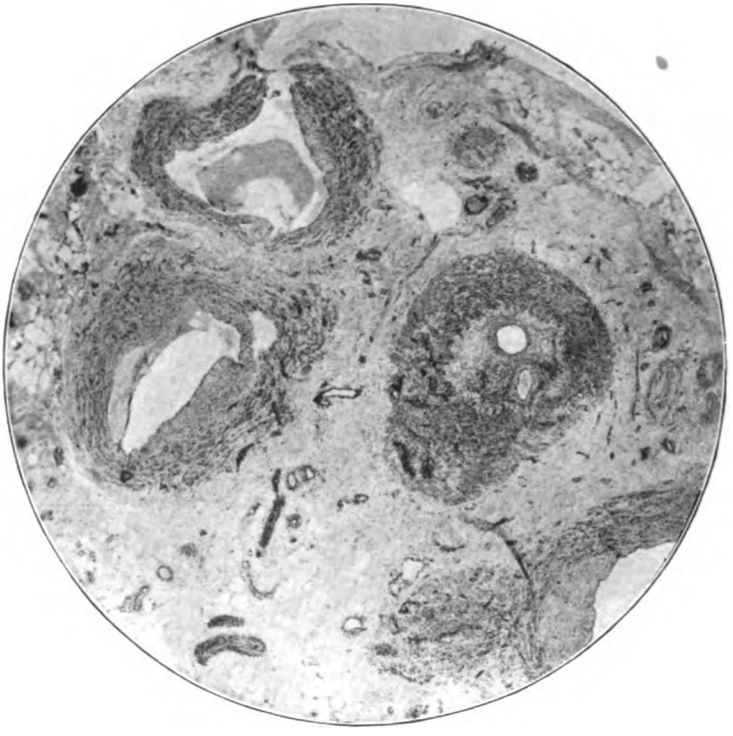

Fig. 4.—Photomicrograph in Case 1, × 20. Section stained with hematoxylin and eosin; from posterior tibial vessels. Note the artery to the right and the accompanying veins. The veins are but slightly affected. The thrombus in the artery has been organized and is canalized by two vessels.

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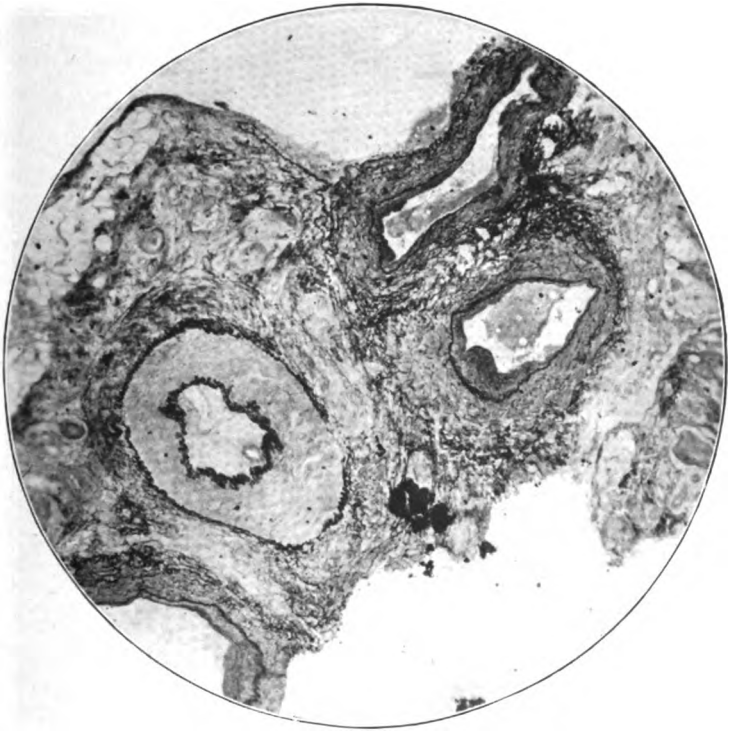

Fig. 5.—Photomicrograph in Case 1, × 20. This section is stained with orcein, which brings out the elastic tissue, and shows the old clot in the artery which is organized and canalized by two vessels. Posterior tibial vessels. Note the distinct absence of elastic tissue within the organized thrombus.

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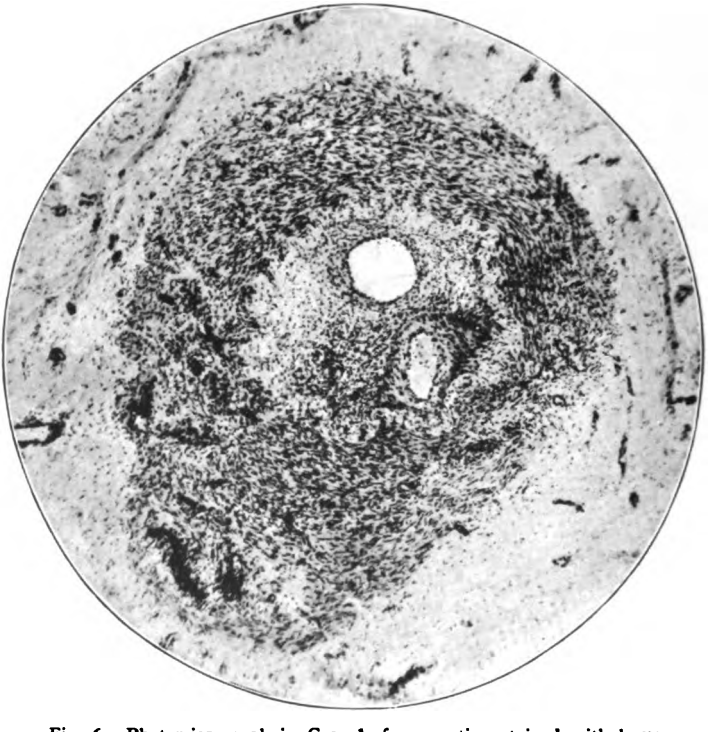

Fig. 6.—Photomicrograph in Case 1, from section stained with hematoxylin, × 45. The inner elastic membrane is shown and within this is the old organized clot, canalized by two vessels. From posterior tibial artery.

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Fig. 7.—Photomicrograph in Case 1, from section stained with orcein to bring out the elastic tissue. × 45. From posterior tibial artery.

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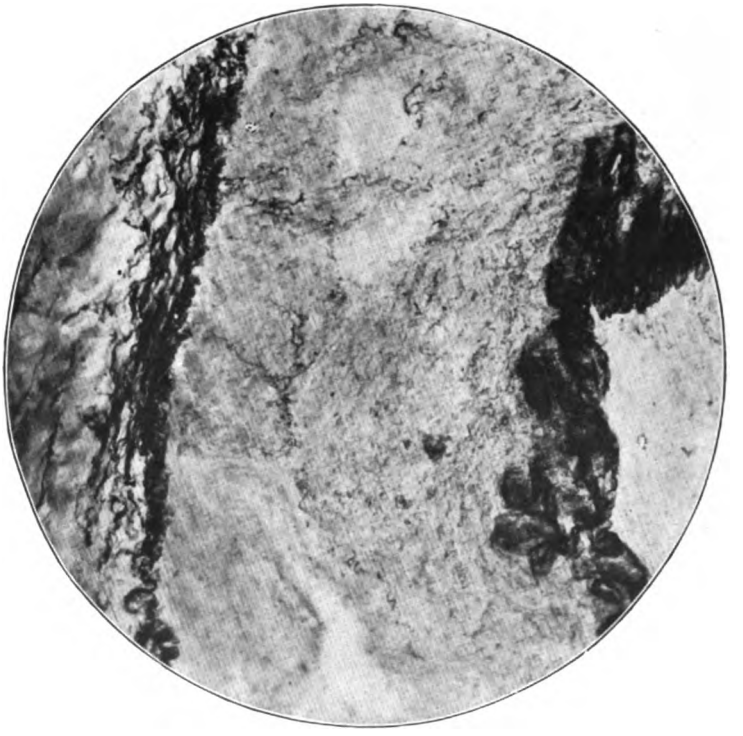

Fig. 8.—Higher power (× 150) of Figure 7, showing inner and outer elastic membrane.

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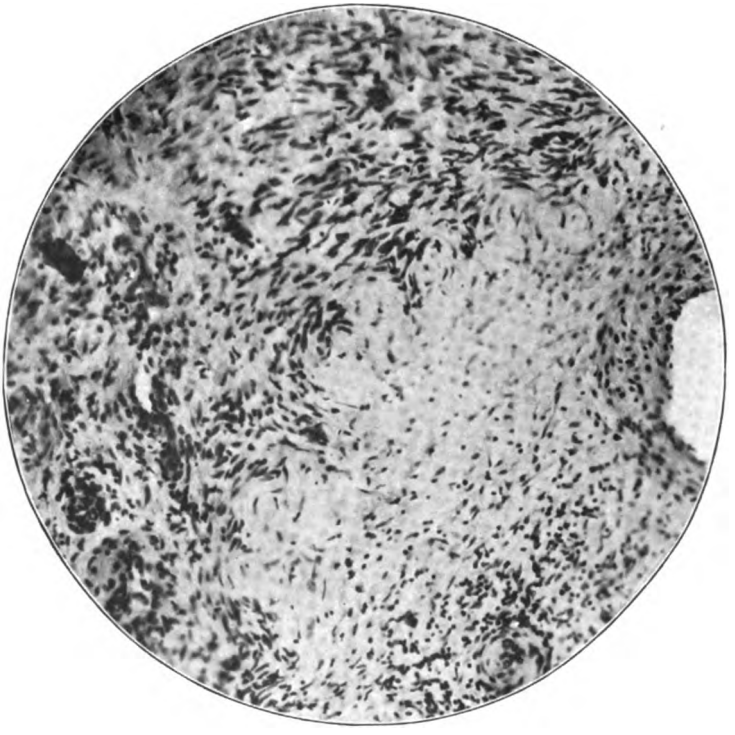

Fig. 9.—Higher power (× 150) of Figure 6. On the right is part of the lumen of one of the canalizing vessels. Through the center of the photograph runs the inner elastic membrane. To the left is the media, which is still well vascularized.

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artery and femoral vein were divided about 2 inches below Poupart's ligament, and the central end of the artery was united to the distal end of the vein end to end by means of a double mattress suture, the technic of which has been described elsewhere.[9] The animals were killed at periods varying from half an hour to forty-six days after operation. A cinnabar mass was injected into the circulation just above the anastomosis. A roentgenogram was taken and then a bismuth mass was injected into the abdominal aorta, after which another roentgenogram was taken. The specimens were dissected by the late Dr. R. H. Whitehead, professor of anatomy at the University of Virginia, who found that the dissections corresponded quite closely to the Roentgen-ray findings. The report[10] of these experiments and the report[11] of an experiment on another animal which was similarly injected and killed after sixty-nine days have been published.

All of these experiments show that in no instance did the injection material in the reversed circulation reach the foot; in most cases it went only a short distance below the knee. In all the animals that lived longer than a few days, the injected mass was quickly transferred by large anastomosing veins to the iliac veins and through them to the vena cava. The arterial blood must have followed the same course as the injected fluid, which, in the reversed circulation, rarely went lower than midway between the knee and the ankle. De Witt Stetten[12] arrives at the same conclusion, namely, that arterial blood in a reversed circulation goes but a short distance below the point of anastomosis and never reaches the tissue which most needs the nutrition. His deductions are from experiments on limbs that were amputated because of slow gangrene.

9. Horsley, J. Shelton: Surgery of the Blood Vessels, St. Louis, C. V. Mosby Company, 1915, p. 46.
10. Horsley, J. S., and Whitehead, R. H.: A Study of Reversal of the Circulation in the Lower Extremity, The Journal A. M. A., March 13, 1915, p. 873.
11. Horsley, J. S.: Ann. Surg., March, 1916, p. 277.
12. Stetten, De Witt: Surg., Gynec. and Obst., April, 1915, p. 381.

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After the arterial blood is switched into the veins, the large valves in the veins are quickly broken down, and the arterial blood in the reversed large vein then rushes into the smaller veins. The smaller valves in the small veins require relatively more force to overcome them than the larger valves in the large vein because of the relation of cubical contents to square surface, and soon the reversed arterial blood reaches a point at which the valves in the small veins check it permanently. These valves probably thicken, and the collateral circulation increases. With the increase of the collateral circulation the pressure on the obstructing valves is reduced and, instead of the constant pounding of the heart tending to break these valves, it seems to do just the reverse. This is clearly shown by an experiment in which the dog lived sixty-nine days and in which the arterial blood went but little farther down the leg than it did in a dog that was injected half an hour after the circulation was reversed. Valves that are not overcome within the first few minutes have less and less pressure on them until the collateral circulation develops to the maximum.

The benefit obtained by reversal of circulation in threatened gangrene is clearly not due to the fact that the arterial blood in the reversed vein reaches the affected tissue, but it is because the obstruction in the venous return causes blood delivered from the arteries to linger in the tissues longer than it otherwise would. If we suppose, for instance, that it takes a definite number of seconds for tissues to take up a proper amount of nourishment from the arterial blood and that the carrying power of the arteries has been reduced to one fifth of their normal capacity, while the veins have been but slightly affected, it can easily be seen that the small amount of arterial blood that does reach the tissues is taken away by the comparatively unimpaired venous circulation more quickly than normally, before it can give up proper nutriment to the tissues.

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On this account, then, the arterial blood, instead of remaining in the tissues the physiologic time, seems to be drained away too quickly, whereas the obstruction in the venous return produced by an arteriovenous anastomosis would dam back the arterial blood, and cause it to remain in the tissues a longer time and so give up more of its nutrition than it could if the venous return were unobstructed.

Ligation of the femoral vein, as done by von Oppel, Coenen, Lilienthal and others, will produce this obstruction to the venous return more accurately and with much less danger than reversal of the circulation, and is an operation that can be done in a few minutes under local anesthesia. It is indicated in threatened or early dry gangrene when the veins are not too greatly involved.

In two cases reported below, one gangrene from thrombo-angiitis obliterans and the other from arteriosclerosis, this operation of ligating the femoral vein was done. In the first case it was done on one femoral vein, in the second case on both.

REPORT OF CASES

CASE 1.—*History.*—M., man, aged 26, single, is a carriage painter, though he has not worked at this trade for five years. He is an American, born in Virginia. There is no history of any Jewish ancestry. His father, aged 54, is in good health. There is no tuberculosis or cancer in the family except that his grandmother died of cancer of the neck. His mother died following childbirth. The patient had three brothers, all of whom are dead; one died from typhoid, one was drowned and one died from an unknown cause.

Except for the present trouble, the patient has never been seriously sick, though he had mumps and chickenpox when young and a slight attack of malaria about seven years ago. He denies ever having had any venereal disease. Two Wassermanns have been made, both of which were negative.

The first symptoms began about September, 1909. Pus formed under the nails of the second and third toe of the right foot, accompanied by considerable pain. The toes and adjoining portion of the foot were very red and swollen and became gangrenous. The affected toes were removed by Dr. Robert C. Bryan. Healing was sluggish and was not complete for nearly two years, but there has been no trouble

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with the right foot since. About September, 1913, the patient began suffering with the great toe and second toe of the left foot. These toes became red and painful, and amputation was done in May, 1914. Healing was slow, but was complete in a few months. For a year after the amputation he was free from pain. About July, 1915, pain returned in the left foot, followed by dark redness on the inner side of the foot near the stump of the amputated great toe. The pain was intense and required large doses of morphin for its relief. Sept. 9, 1915, the left femoral vein was ligated with catgut, under novocain, in the upper part of Hunter's canal. A few minutes after ligation, the left foot, which had been cold, became warm and congested. The condition of the foot seemed to improve for a few days, though the pain continued. Two weeks after the operation, however, gangrene began to spread, and dark mottled spots appeared over the dorsum of the foot. Amputation of the left leg was then done, Oct. 2, 1915, under ether, at about the junction of the upper and middle third of the leg. No tourniquet was used, the vessels being ligated as exposed. The wound was closed with silkworm-gut sutures, lightly tied. Healing was by first intention. The patient left the hospital in good condition, Nov. 6, 1915. There has been no pain or trouble of any kind in the stump of the leg since the operation, and there is at present, seven months after operation, no tenderness on pressure on the stump. The patient has ordered an artificial leg. He has some pain in the hands and wrists, which may be due to the use of crutches.

Laboratory Examination.—Portions of the posterior tibial and of the anterior tibial vessels were dissected from the amputated leg, and serial sections were made in the laboratory of Dr. H. T. Marshall, professor of pathology in the University of Virginia, Department of Medicine. The sections were variously stained with hematoxylin and eosin, orcein, or van Gieson's stain. The findings show, according to Dr. Marshall, who has devoted much time to a study of these sections, evidence of old thrombus deposit. Dr. Leo Buerger, who kindly examined the sections, reports that they undoubtedly show lesions of an old thrombo-angiitis obliterans. The inner elastic membrane is distinctly seen. The sections stained with orcein, an elastic tissue stain, show plainly that there is no excess of elastic tissue within the inner elastic membrane, which does occur in the endarteritis of arteriosclerosis. Organization and canalization of the thrombus is seen in the sections. Two fairly large vessels canalize the old thrombus, and one of them in a section stained with orcein (Fig. 7) can be seen to approach the internal elastic membrane, a feature which, according to Buerger, is distinctive, as these vessels tend to divide and may actually penetrate the internal elastic membrane and enter the media.

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CASE 2.—A preliminary report[13] on this case has been published. At the time the article which contained the report was written, the patient was living, though when the proof sheet was received he had died and a note was made to that effect.

History.—Man, aged 70, white, had had a positive Wassermann reaction. In December, 1913, he began losing strength and weight, and his physician, Dr. George Ross, found both sugar and albumin in the urine in considerable quantities. In the fall of 1914 a dark line appeared on the heel of the right foot, and a corn on the little toe of the same foot became painful and red, and a little later showed marked discoloration. A scratch on the right leg, about 2 inches above the external malleolus, was the beginning of an ulcer which gradually extended until it became an inch in diameter. On admission to the hospital, April 9, 1915, this ulcer, evidently the result of a small area of superficial gangrene, had attained its largest size. The little toe of the right foot was completely gangrenous with a line of demarcation around its base. There was an area of dry gangrene covering the right heel, 2½ inches in diameter. Both feet were swollen and painful. On the left heel there was a dark crack 1¼ inches long. The skin was red and desquamating over the dorsum of the left foot, though the toes were pale. The left foot was undergoing the same changes as the right foot underwent before gangrene set in.

Operation and Results.—On the day of admission, April 9, 1915, the femoral veins in both thighs were ligated with catgut, under local anesthesia, in the upper part of Hunter's canal. The superficial veins in both legs became filled and prominent immediately after the ligation. The gangrenous right toe was removed. The day following the operation there was less pain, the edema in the left foot had entirely disappeared, and that in the right foot was almost gone. This was unusual, for ligation of the veins is supposed to predispose to edema if it does not cause it. Probably the better balanced circulation permitted the arterial blood to take up the fluid in the tissues. Two weeks after operation the patient was discharged from the hospital. At that time there was no swelling in either foot, and the pain was practically gone. The wound at the base of the little toe of the right foot had a few granulations, and the gangrenous tissue in the right heel was beginning to separate. The ulcer above the external malleolus was healing, and the patient expressed himself as feeling much better.

May 3, 1915, I saw the patient at his residence. The swelling had returned in both feet, though it was not so bad as before the operation. Pain had also increased, and the small discolored crack in the left heel was unchanged. The ulcer

13. Horsley, J. S.: South. Med. Jour., November, 1915.

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above the right malleolus had entirely healed and was covered with smooth skin. Later the stump of the little toe on the right foot became infected at the patient's home where dressings could not be well done, and pus burrowed into the foot. The leg was amputated under local anesthesia, May 15, 1915. No tourniquet was used. Though the healing was slow, there was no gangrene. The diabetes and albuminuria continued. About the middle of June, gangrene of the left foot spread rapidly from the little toe. The patient died, July 10, 1915. No further operation was done as, with sugar and albumin abundant in his urine, further operation was obviously useless. The patient was syphilitic, diabetic, nephritic and 70 years old. We had no right to expect much in a case of this kind, but the patient was satisfied that he had obtained benefit, particularly in the decrease of pain and in the healing of the ulcer above the external malleolus.

CONCLUSIONS

While in neither of these cases were the clinical results after ligation of the femoral vein permanently successful, there was some temporary improvement in each case, slight though it was in the first. The results, however, compare very well with the favorable results usually reported from operations for reversal of the circulation by arteriovenous anastomosis in which the improvement consists in a better color and more warmth in the foot with lessening of pain. Results of this kind can be equally well obtained by ligating the femoral vein. In very early cases of slow gangrene in which the veins are unaffected or but slightly involved, it is possible that this simple operation may give relief for a long time or, in a few instances, may be permanently beneficial.

ABSTRACT OF DISCUSSION

Dr. De Witt Stetten, New York: I wish Dr. Horsley would abandon the term "reversal of the circulation." I know that we have identical opinions on arteriovenous anastomosis, which we have reached simultaneously but by different routes. My injection experiments on limbs amputated for gangrene of various sorts where arteriovenous anastomosis would have been indicated show conclusively that the arterial circulation to the periphery, even in very advanced arterial disease, is better and easier than the retrograde venous circulation, because of the obstruction of the valves and the short-

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circuiting of the blood through anastomoses of venous collaterals. But, the operation is dangerous and the results have been most unsatisfactory in the vast majority of cases. The few so-called successful results have been obtained more in spite of than because of the operation, as various factors play a rôle in the improvement, as improvement has occurred after definite closure and failure has followed perfect patency of the arteriovenous fistula. Even if the anastomosis functionates, which it rarely does, there can be no circulatory improvement, but rather the reverse. Even if the operation were definitely proved useful, the possible indications would be restricted to almost nil. Dr. Horsley's animal experiments have substantiated my conclusions. Regarding von Oppel's ligation of the femoral vein, I did feel with Dr. Horsley that whatever success followed arteriovenous anastomosis was due to the same circulatory conditions that followed ligation, yet, while I do not wish to be understood as doubting the utility of ligation, I must confess that, if it helps, I cannot quite understand the reason. I still favor ultraconservatism in the treatment of all types of gangrene—avoiding any operation as long as possible. Besides systemic treatment of the patient and surgical treatment of the wound, baking, warm baths, alternating hot and cold baths, posture, rest, moist dressings, etc., have given the best results, which, while not as striking nor as prompt in the thrombo-angiitis obliterans and senile varieties as in the diabetic cases, are nevertheless obtained with patience, and many limbs and lives are saved. The treatment by hypodermoclyses, I believe, improves the patient's general tone and thus aids in the recovery. Concerning the microbic theory of thrombo-angiitis obliterans, I cannot conceive of an infectious disease limited to one sex and practically to one race. Among the many patients I have treated, I have never seen a female, and except for one Russian Christian, all the rest have been Russian, Polish or Galician Jews. I am convinced that the causative factors of this disease are of a nature similar to those of hemophilia, i. e., that some abnormality of the blood or instability of the vascular system has developed in certain racial groups, that this is transmitted to the males and becomes evident between the ages of 20 and 35. Although, as yet, definite proof of the hereditary nature of the disease is lacking, certain observations by Dr. Garbat tend to confirm these impressions.

Dr. Charles Goodman, New York: In reply to the arguments against the advisability of performing an arteriovenous anastomosis for presenile gangrene, I should like to call attention to the many instances in surgery in which an operation is condemned theoretically on anatomic and physiologic grounds, and yet yields a surprising practical benefit. Take, for example, gastro-enterostomy. The jejunum was never meant to have any direct communication with the stomach, yet with the modern perfected technic this operation has

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attained a recognized place in surgery. Intravenous saline infusion after hemorrhage and shock is another instance. We cannot forget that there is such a thing as the adaptability of living tissue to changed conditions without which we could not practice surgery. So, in arteriovenous anastomosis for the relief of obstructed circulation of the extremities, it is not definitely known how much of the circulation reaches the periphery or how the reversal of the circulation takes place, but we have clinical evidence that the symptoms were relieved shortly after the operation for an indefinite period. All writers agree that these cases eventually come to a high amputation. We have had clinical evidences that trophic ulcers which had resisted all other forms of treatment take on appearances of repair and heal. An extremity previously cold and cadaverous has become warm and pink, pulsation could be felt distinctly in the veins peripheral to the anastomosis, and superficial veins have become distended. Pain has been relieved and the parts threatened or the actual seat of gangrene returned to normal. We cannot disprove the practicability of the operation as a palliative measure under proper indications. A study of the disease from an ethnological and historical point of view led me to believe that endarteritis obliterans and thrombo-angiitis are late manifestations of a previous typhus infection. Serologic tests have shown a complete agglutination reaction in at least three of twenty-one specimens of blood. We had a three plus complement fixation reaction in one patient and a four plus complement in two. One of these with the most pronounced reaction had active lesions.

Dr. Nathaniel Ginsburg, Philadelphia: In considering this form of peripheral vascular disturbance, it is most important to distinguish sharply between the various types of circulatory failure. Dr. Horsley has contributed some very important observations to our knowledge concerning the possibility of so-called reversal of the circulation. I have long believed that this operation is founded on a faulty anatomic and physiologic basis, and that laboratory experimentation with animals could only be applied to the human being so far as the technical features of the anastomosis are concerned. With reference to diabetic gangrene, and peripheral gangrene due to arteriosclerotic changes, it is my belief that surgery in the first type of cases should be sparing, and as conservative as possible. In this class of cases I pay particular attention to the acidosis present, making every effort to reduce the ketonuria by means of the Allen treatment and other measures which have for their purpose the rapid and effective reduction in the sugar content in the blood. With regard to senile gangrene, no measure can overcome the pathology present in the peripheral vessels, and a circulatory failure cannot be reestablished by any means at our disposal. Peripheral gangrene, known as thrombo-angiitis obliterans is a distinct clini-

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cal entity about whose syndrome we have little knowledge so far as the etiologic factors are concerned. It is important to distinguish this class of cases of peripheral blood vessel disturbance, and to confine to this class those young or middle aged adult males of Russian, Galician, or Lithuanian birth of the Hebrew race, in whom this disease is always found. While it is true that Ochsner has observed this condition in Swedes, and Kogo and Mayesima of Japan have studied and reported the occurrence of this condition in the Japanese, in this country practically all the cases observed have been in the type above stated and exclusively in the male sex. I have been impressed by the fact that some vague toxic factor is the underlying cause of this condition. These patients, as a rule, are inveterate cigaret smokers and have been exposed, through occupation and dire necessity, to climatic conditions which, plus constant static position, have predisposed to peripheral circulatory failure. The large majority of these cases includes men engaged in baking, barbering, street venders and machine workers, where there is constant standing on the feet over long periods of time. Von Oppel has performed femoral vein ligation in these cases, believing that the peripheral venous stasis thereby induced in the affected limbs, from the physiologic point of view, has the same relative surgical value as arteriovenous anastomosis. Kogo and Mayesima found that these patients have an increased viscosity of the blood, and they have made effectual attempts by employing sodium citrate solution for intravenous injection to reduce the increased viscosity. They do not report in their list of fifteen cases any instance of femoral vein ligation. Garbat of New York recently stated that multiple injections of 2 per cent. sodium citrate solution into the veins did not have a deleterious effect. I have employed femoral vein ligation in four cases with coincident injections of Ringer's solution, and 2 per cent. solution of sodium citrate. There is every reason to believe that in three of these cases a very marked benefit has resulted, and in one instance the patient has begged for the same procedure in the other limb. I hope to report these and other cases with more detail with reference to the end results attained, and the real value attaching to femoral vein ligation in cases of this particular type. We have tried foot baths, heat, Bier's hyperemia, electrotherapy, heliotherapy, and the employment of many drugs, all of which have been of no value so far as the course of the disease is concerned. Finally, it must be borne in mind that the disease we are treating is one in which there is definite pathologic change in the peripheral blood vessels, evidenced by microscopic study of the sections removed; the disease being seen in its late stages and therefore often beyond any other palliative means of treatment.

Dr. Carl Beck, Chicago: Dr. Horsley mentioned that Dr. Carrel depended on the change of color when judging the

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results of his anastomosis, declaring that the brighter color of the vein indicated that arterial blood was passing through it. Dr. Carrel depended, as I can state from actual experience with him, on the pulsation of the vein. This was clearly proven to me to be the case in one instance, which I have not published myself, but which is included in the publication of Dr. Halsted of Chicago, to whom I gave the details of the case when he published a series of anastomosis of blood vessels. I have had several cases in which I reversed the circulation by anastomosis, but this particular one was of the greatest interest. The patient was a man with gangrene of both feet, progressive, and without tendency to demarcation. After some weeks of observation, we decided to make an arteriovenous anastomosis, which we did without any mishap. Demarcation took place at once, not only on the limb which was operated on but also on the other limb. The dead portions of the feet, clear up to the tarsocrural joint, dropped off, and when the stumps granulated, we decided to amputate the badly looking stumps and make healthy and functionally good stumps by reamputation.

That the artery drained into the vein was proved to me by the spurting of every vein on the side where the anastomosis had been performed. Two interns operated at the same time and I watched the operation: On one side spurting of veins, on the other none at all. That shows that anastomosis will reverse the circulation. Whether it will be beneficial for gangrene is another question.

Dr. George Morris Dorrance, Philadelphia: Since the time that Dr. Carrel introduced his method of reversing the circulation, none of our experimental or clinical work has been satisfactory. We studied the reversal in the dog by injecting thorium above the anastomosis with approximately the same pressure as the dog's heart and found by Roentgen ray that practically all of it returned from the first or second branch of the vein and we did not obtain a complete reversal. In man, you have the added difficulty of an arteriosclerotic artery. At best there will be a large number of closures of the anastomoses. From a careful analysis of both the clinical and laboratory work, I find that what little success is obtained is due to ligation of the vein. Experiments made on the cadaver, though faulty, have led to the same conclusions. Of course, it is here necessary to first wash out the vessels. Working along these lines, I cannot see what is the use of fooling with these cases and dragging them along. Why not amputate early, providing the ligation of the vein does not give you results? Get these people back to work again.

Dr. Ernest Laplace, Philadelphia: Dr. Dorrance has given us the keynote to the practical side of the question. This gangrene is not a local trouble. It is a local manifestation the real nature of which is unknown to us and is a puzzle in surgical pathology today. It affects certain people of the

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Jewish race and the male sex only, so far as we know. In the vast majority of cases I believe the specific treatment will do some good with or without knowing exactly the reason it does so. The disease is more manifest in the toe because the circulation is weakest there. After the amputation what then? In the vast majority of instances on the eighth day there is a black line around the edge of the stump and there is a repetition of the condition. I believe it is poor surgery under the circumstances to sew that wound up. I have had almost 100 cases of this in the last twenty-five years and found it unsafe to sew these wounds up. There is some poison that prevents healing of the wound. There is something lacking in the blood of that particular case. This struck me long ago as being the case and therefore I determined about ten years ago to substitute human serum to the wound. Ascitic serum is kept on ice at 1 C.; this is used to bathe the wound constantly. The wound will generate healthy granulations and heal kindly. Though I have not published this before I have still to see a recurrence in cases treated as above. A necessary amputation high up should be treated in the same way. I believe that in ordinary serum there is something which the patient needs to make the wound a healthy one. I believe the results are so striking that it is now time that I should make them known.

Dr. J. Frank Corbett, Minneapolis: When one attempts to review the literature of senile gangrene one is impressed by the multiplicity of remedial measures. Each particular remedy has been accredited with success. None of these have ever come into general use. Therefore one is inclined to conclude that the collateral circulation accomplishes a great deal sometimes and is given very little credit. I do not believe that experimental work on animals is of much value in determining the treatment of senile gangrene. In the first place, gangrene is common in the lower extremity and the blood supply of the leg in animals is very different from that of man. In addition to that, when we come to study the limbs which have been amputated for senile gangrene we find there are many general changes aside from the local anatomic changes. When we take such a limb and perfuse it with Ringer's solution under conditions imitating the blood pressure and pulse pressure of that member, we find that through the arterial side the rate of flow is very different in senile gangrene from what it is normally. In addition to that we find even in cases that are not recognized as diabetic changes in the blood sugar. I have been surprised at the high sugar content of the blood of some of our cases where nothing came through in the urine. In addition to this, these cases are usually complicated with kidney lesions and we find that the blood has an increased urea and other components. I am just beginning a study on the viscosity of the

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blood, in which, to my surprise, I find an increased viscosity occurs in other conditions besides thrombo-angiitis obliterans. Therefore, I do not believe we are at the present time in a position to say positively that we have a remedy in anything short of amputation. In the normal limb it is impossible to reverse the circulation in twenty-four hours of perfusion with the best apparatus I could make to represent the heart's action. Sometimes after hours of such perfusion we got a few cubic centimeters of fluid. I do not believe that the blood that we got through by breaking down these damaged vein valves and working back was anywhere near enough to supply the vitality of the limb. But possibly some such condition as that may account for the early successes and improvements reported by Bernheim.

Dr. J. Shelton Horsley, Richmond, Va.: I am not proposing any operation that cures all cases of threatened gangrene. Ligation of the femoral vein is a procedure originally proposed by von Oppel and, in certain types of threatened gangrene, seems to help. In the early stages of thrombo-angiitis just before the clot forms all of the coats of the vessel are infiltrated with small round cells and the infiltration does not disappear until the clot is well organized. This certainly seems to indicate an inflammatory origin. Practical clinical knowledge should go hand in hand with laboratory work. If the gentlemen who object to the conclusions that we have reached are not convinced by the evidence, which includes the usual injection method of studying blood vessels, roentgenograms, dissections by a professor of anatomy, and then the work of Stetten on limbs amputated for this very disease, I confess I do not know what will move them. The reversed vein will, of course, spurt if it is cut before the blood reaches the valves in the smaller veins. It is mainly the relation of cubical contents to square surface, and if a large varicose vein would reach to the foot probably the reversed injection would go there also. This does not in any way alter the situation. Our experimental work together with the experimental work of Stetten on amputated limbs shows that in no single instance did the reversed circulation ever reach the foot. The clinical improvement following reversal of the circulation has already been explained in the paper and is due to the balancing of the circulation. I am not an advocate of any one method of treatment for slow or threatened gangrene, though I think in certain instances ligation of the femoral vein may be helpful.

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STAB WOUNDS OF THE CHEST INVOLVING THE DIAPHRAGM

WITH DIAPHRAGMATIC HERNIA OR EVISCERATION

CHARLES C. GREEN, M.D.
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Although man has inhabited this world nearly 8,000 years and has possessed a temper since the time of Cain and Abel, and has had in his possession a knife or some kindred instrument, with which he has inflicted wounds in almost every portion of the human anatomy, yet not until recently have there appeared in literature any reports of stab wounds of the diaphragm, with diaphragmatic hernia, or evisceration.

The question then naturally arises, Is there an increase of this character of injuries, or are we becoming better diagnosticians and now recognize them, where they were previously overlooked?

The latter is the more logical conclusion, as there has been no change in the anatomy of man, and little or none in the character of cutlery used by him in settling his personal difficulties.

The term "hernia," as applied in these cases, is a misnomer, since hernia always has a sac, which in these cases is lacking. Consequently the term "evisceration," which is used entirely by the French writers, is the more correct.

Diaphragmatic hernia and evisceration are found on the right side in 8 per cent., and on the left side in 92 per cent. of all cases. The small percentage of cases found on the right side is due to the fact that the liver is situated on this side, and acts as a plug for almost any opening that may be made in this locality.

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Quite recently, a great deal has been written on this subject, and the most comprehensive articles have been contributed by Wolf, Iselin, Suter and Magoula.

Magoula's article was published in 1910, and includes all cases previously reported by Wolf, Iselin and Suter, with some additional cases. Therefore, I invite attention to a brief review of this paper.

Magoula reviewed the whole subject of stab wounds of the chest in 1910, and reported 190 cases of injury to the diaphragm; but by no means did all of these have hernias.

Of the sixty-four cases reported by Suter, forty-four cases showed protrusion at the outer wound; five showed protrusion of the omentum into the pleura; ten showed only slight protrusion through the diaphragm, and five showed the stomach herniated through the diaphragm.

Of the thirteen cases reported by Wolf, five showed hernia.

Of sixty-one personal cases reported by Magoula, nine showed the omentum at the outer wound, and four showed protrusion through the diaphragm.

Of forty other cases collected by Magoula, twelve showed the omentum at the outer wound, and four showed the viscera through the diaphragm.

Hence, of the 190 cases reported by Magoula, ninety-eight, or nearly 52 per cent., showed hernia, or better, evisceration.

From this brief review it is seen that the total number of cases of wounds of the chest, involving the diaphragm, with a hernia, is ninety-eight, plus twenty-five others that have been reported since the publication of Magoula's paper, as follows: Bamberger, Frassi, Caffee, Gautierand Du Seutre, Fato, Gourevitch, Gougorlof, Klaggs and Krymholz, each one; McGuire, Negroni and Wiess, each two; Jobes three, and Davis seven, making a grand total of 123 cases which have been reported.

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To this number I wish to add six cases which I treated at St. Joseph's Infirmary, Houston, Texas.

REPORT OF CASES

CASE 1.—Man, aged 28, white, married, was admitted to the hospital with a stab wound of the left chest just posterior to the midaxillary line, through which about 6 inches of omentum were protruding, at the ninth interspace. The wound was inflicted by his wife with a carving knife. He was immediately given ½ grain of morphin and 1/150 grain

COMPLETE REVIEW OF LITERATURE ON STAB WOUND OF DIAPHRAGM, WITH HERNIA, UP TO JUNE, 1916

Authors	Reference	No. of Cases
1. Suter, F. A. ..	Beitr. z. klin. Chir., 1905, xlvi, 341	61
2. Suter, F. A. ..	Beitr. z. klin. Chir., xlvii, 403....	Increased to 64
3. Iselin.....	Deutsch. Ztschr. f. Chir., 1907, lxxxviii, 150	Cases included in Suter's report
4. Wolf.....	Deutsch. Ztschr. f. Chir., 1910, iv, 169	5
5. Magoula. M. .	Arch. f. klin. Chir.	29
6. Bamberger....	THE JOURNAL A. M. A., Dec. 31, 1910, p. 2296	1
7. Caffee, B. V. .	THE JOURNAL A. M. A., July 1, 1911, p. 20	1
8. Fato.....	Bull. et mém. Soc. de radiol. méd. (Paris), 1912, iv, 100	1
9. Frassi.....	Osped. Magg. (Milan), 1910, iv, 356	1
10. Gautier and De Seutre	Bull. de la Soc. méd. chir. de Chine, 1910, p. 152	1
11. Gourevitch....	Russk. Vrach., 1915, xii, 254.....	1
12. Gourgolof....	Chirourguitchesky Arch. (Vetianinova), 1910, xxvi, 594	1
13. Jobes, N. E. ..	Indianapolis Med. Jour., 1914, xvii, 89	3
14. Klaggs.....	Lancet, London, Aug. 6, 1904, p. 361	1
15. Krymholz.....	Chrourg., 1910, xxviii, 737.....	1
16. McGuire, S. ...	South. Med. Jour., 1914, vii, 733; reports one case since then	1
17. Negroni.....	Gazz. d. osp.	2
18. Weiss.....	Rev. méd. de l'est, 1910, xlii, 314....	2
19. Davis.....	South. Surg. and Gynec. Assn., 1914, p. 334	7
20. Green, C. C. ..	Am. Med. Assn., 1916, Detroit.....	6

of atropin. He was taken to the operating room, and under anesthesia a median incision was made. A careful examination of the cavity showed that there were two incisions in the omentum, and a small incision in the stomach through all coats except the mucous membrane. The bleeding points were caught and ligated, and the incision in the stomach was closed with a fine catgut suture.

Further examination of the cavity disclosed the fact that there was an opening in the diaphragm, through which some of the viscera had escaped into the thoracic cavity. With one hand in the cavity I succeeded in replacing them, but

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they were immediately sucked back into the thorax, with a great deal of force and an audible, sucking sound. The abdomen was then closed, as we found it next to impossible to conclude the operation through this opening. We then enlarged the wound of entrance, excised a portion of the rib, and, on inspection, found that all of the transverse colon, and omentum, a portion of the descending colon and jejunum and stomach were in the thoracic cavity. After some difficulty, they were replaced into the abdominal cavity, and the edges of the rent in the diaphragm were caught up with forceps and sutured with No. 3 chromic catgut, and the outer wound was closed without drainage.

The patient was then taken to the ward and made an uneventful recovery. He left the hospital in twelve days, and today is in perfect health.

Case 2.—Man, aged 32, white, married, was brought into the hospital with a stab wound of the left chest in the mid-axillary line, at the seventh interspace, with 4 inches of omentum protruding. He was suffering from profound shock, but reacted nicely after the administration of ½ grain of morphin and 1/150 grain of atropin. He was then taken to the operating room and under ether anesthesia, a median incision was made. A portion of omentum and stomach was found in the thoracic cavity with a large rent in it, from which there was profuse hemorrhage. This point was picked up and ligated, and, no other injury being found, the abdomen was closed in the usual way. The wound of entrance was then enlarged, as in the first case, but we did not find it necessary to resect the rib. The stomach and omentum were returned into the abdominal cavity, the opening was closed as in Case 1, and the patient was sent to the ward. This man had a stormy time, as he developed an acute dilatation of the stomach on the second day after the operation; but by free use of the stomach tube he recovered, and left the hospital on the fifteenth day and, when last heard of, was in good health.

Case 3.—Man, aged 28, colored, married, was brought into the hospital markedly intoxicated, with a stab wound in the left chest about 1 inch posterior to the midaxillary line at the eighth interspace, with 3 or 4 inches of omentum protruding. He was profoundly shocked when admitted. He was given ½ grain of morphin and 1/150 grain of atropin. He was then taken to the operating room and under ether anesthesia, a median incision was made. The transverse colon and omentum were found in the chest cavity; a slit in the omentum, and a considerable amount of blood were found in the abdominal cavity. The bleeding point was caught up and ligated, and the abdomen closed, and the thoracotomy performed as in the previous case. The patient was sent to the ward and did fairly well for about fifteen hours, when he began to be very restless; his temperature

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began to rise, his kidneys became rather sluggish, and in spite of all we could do for him, he died about forty-eight hours after the operation, from what we diagnosed as acidosis.

CASE 4.—Man, aged 26, colored, single, was brought into the hospital with a stab wound of the left side at the seventh interspace, in the midaxillary line, with about 3 inches of omentum protruding through the external wound. This patient was so profoundly intoxicated that he could not stand up. He complained of very little pain, and that was near the sternum. His abdomen was opened and examined, and a large amount of omentum was found in the thorax; there was found in the transverse colon an opening about 2 inches long. This was closed and a drain left in the abdominal incision, as some feces were found in the cavity. The chest was opened, as in the previous case, and the opening in the diaphragm closed without any difficulty. The patient was sent to the ward and did very well for the first twenty-four hours, when he developed almost the same symptoms as those in the previous case, and died in thirty-six hours after the operation.

CASE 5.—Man, aged 26, white, single, was brought into the hospital with a stab wound of the left side at the tenth interspace about 3 inches posterior to the midaxillary line. He showed a fair amount of shock, and had 6 inches of omentum protruding through the external wound. The abdomen was opened in the usual way, and a portion of the stomach was found in the thorax; there was a wound in the gastrocolic omentum, which was bleeding rather freely. This bleeding point was ligated, and the chest opened in the usual way, after the abdomen had been closed without drainage. The patient was sent to the ward and given the usual treatment, namely, ¼ grain of morphin according to circumstances, water freely, and allowed change of position when desired. After forty-eight hours he was given a saline cathartic and the next day was given a light diet. He made an uneventful recovery and left the hospital on the tenth day; when last seen he was in the best of health.

CASE 6.—Man, aged 30, white, single, entered the hospital with two stab wounds of the left chest, one at the seventh interspace anterior to the midaxillary line, and the other at the ninth interspace 3 inches posterior to the midaxillary line. Being on the lookout for this class of cases, we at once thought of a stab wound of the diaphragm and decided to do an exploratory thoracotomy. We first enlarged the upper wound, but could not detect any injury to the diaphragm at this point; so we closed this opening and enlarged the lower wound, where we found a small opening in the diaphragm, with a portion of the omentum in the thoracic cavity. This opening was closed without drainage, but the abdomen was not explored, as the patient's condition was so good

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that we could not believe he had received any injury to any of the abdominal viscera. He was sent to the ward and made a very rapid recovery, being able to attend court on the eighth day. He has had no trouble, and now is doing hard work in Houston, apparently in the best of health.

COMMENT

From this report it is evident that the diagnosis was readily made before operation in every case except one, as the omentum was protruding through the external wound in all except the last case.

This is not always the case, however. In many instances, as substantiated by Magoula's report, the diagnosis is not made until months or years later, when the patient begins to show signs of obstruction, as the result of adhesions around the viscera, which have herniated through the opening in the diaphragm. This, in many cases, is not diagnosed except by the use of the Roentgen ray.

As the result of difficulty of diagnosis in most of these cases, we are confronted with questions such as these: First, What is the duty of the surgeon in such cases? Second, How far should he go, and how much time should he spend in attempting to arrive at a diagnosis before he is warranted in doing an exploratory thoracotomy?

The mortality in these cases is very high, both in the complicated and the uncomplicated. For instance, in the uncomplicated cases we find in Magoula's report a mortality of 20 per cent., and in the complicated, 64 per cent.

With such a high mortality, therefore, a surgeon should be very careful not to do anything that would increase the shock, yet he should not sit idly by and allow his patient to go into a profound state of shock before going to the rescue.

Consequently, in cases in which we cannot arrive at a diagnosis quickly, but have reason to believe that there is injury to the diaphragm, and probably to the abdominal viscera, I believe that it is not only the

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surgeon's privilege, but also his duty to resort to an exploratory thoractomy. By this exploratory operation he will be able, not only to control any bleeding, or repair any damage that may have been done to the viscera, but also to close any opening that may have been made in the diaphragm, which, if not closed, may be the cause of a great deal of trouble, or death of the patient in later years.

In conclusion, let me make a plea for the more general use of exploratory thoracotomy in the treatment of these cases, since, if it is properly done, the dangers of the condition are not increased, and certainly many lives will be saved which otherwise would be lost.

ABSTRACT OF DISCUSSION

Dr. James E. Moore, Minneapolis: What shall we do in cases of stab wound in the chest? Too often the tendency has been to wait for the patient to bleed to death before we see whether we could do anything. We were justified somewhat in our hesitation because until recently whenever we attempted to open the thorax we had staring us in the face the collapse of the lung. Then we got the cabinet of Sauerbruch. Fortunately we do not need that today, for we have the simple method of intratracheal insufflation. Giving the anesthetic in that way we can open the thorax with impunity so I would advise every man when he has a patient come to him with a stab wound of the chest, particularly if he knows that the instrument pointed downward, to make an exploratory operation. It is simple and safe and he will save many lives by so doing.

Dr. Charles C. Green, Houston, Tex.: The main danger in thoracotomy is collapse of the lung. It is the principal cause of shock in these cases. In accident cases, such as I have reported, that condition already exists. By enlarging the opening and getting in there, it is a great deal easier to pick up the diaphragm from above and pull it up to the opening in the chest than it is to work from below. After my first operation I found that by making a long intercostal incision it was not necessary even to resect a rib, but having assistants, using small powerful retractors it was easy enough to pull the ribs apart, pick up the diaphragm and suture it. Just as long as you can pick up the diaphragm and hold these edges together there is practically no danger of the viscera being forced up against the diaphragm and included in the suture. I do not see why there should be many deaths unless there is a great deal of shock or trauma.

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SPLENECTOMY IN PERNICIOUS ANEMIA

STUDIES ON BONE MARROW STIMULATION *

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In the study of diseases of the blood and particularly of the effects of therapeutic procedures in such diseases it is necessary that one should be able to estimate by reliable criteria any alteration of the relative rate and degree of destruction and regeneration, at least of the formed constituents of the blood, the erythrocytes, leukocytes and platelets. Such information is particularly desirable in pernicious anemia, in which the spontaneous course of the disease is so bizarre. Marked improvement, usually called a remission, occurs frequently in the course of the disease and may easily be attributed to any incidental therapeutics.

The methods for studying the processes of blood destruction and regeneration are few. The enumeration of the formed elements may or may not be of value. It is evident that a given number of a blood element merely represents the balance of destruction and formation. The red cell destruction can be studied by the excretion of urobilin, and perhaps in certain instances by estimating the bile pigments in the blood.[1] Sellards and Minot [2] have pointed out that the study of the tolerance to injections of hemoglobin in man may perhaps furnish valuable information concerning erythrocytic destruction. The presence in the

* From the Medical Service of the Massachusetts General Hospital.
1. Blankenhorn: Tr. Assn. Am. Phys., 1916.
2. Sellards and Minot: Jour. Med. Research, 1916, xxxiv, 469.

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peripheral blood of the "bodies" described by Rous and Robertson [3] may also throw light on this subject.

The white corpuscle destruction in certain instances may perhaps be studied by the estimation of certain nitrogenous products in the urine.

There are no known methods for studying the destruction of the blood platelets, since we do not know their ultimate fate. We merely know that their life is short, being from three to six days.

The rate and degree of formation of the formed blood elements can be studied clinically in a number of ways. The chief source of these elements is the bone marrow. Thus, in order to gage the power of regeneration and formation of the formed elements, one must study the activity of the marrow. One must scrutinize, not only the increases of bone marrow activity, but also the intensity and quality of that activity and its possible relation to the therapeutic procedure.

Evidence of increased activity on the part of the marrow in the production of red cells may be shown by an increase of young forms of red corpuscles. The presence of increased numbers of reticulated red cells, especially of a certain type, the presence of blasts, Howell-Jolly bodies, polychromatophilia and certain types of stippling should be considered in studying the activity of the bone marrow. Variations of size and shape of the red cells may be of significance in certain cases.

The decreased activity in the production of red cells may be evidenced by an absence of the factors indicating activity. A rising red count does not necessarily mean an increased activity of the marrow, for the count may rise as the result of a lessened destruction. Increased activity is entirely consistent with an anemia when formation does not compensate destruction. Likewise, an extreme grade of anemia may be associated with decreased destruction and caused by decreased formation.

3. Rous and Robertson: Tr. Assn. Am. Phys., 1916.

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Evidence of the activity of the marrow in the production of white cells may be seen in the polynuclear count and perhaps in certain changes in the Arneth formula. A diminished activity is associated with a low polynuclear count and a resulting relative lymphocytic increase. In some instances with diminished activity of the bone marrow the liver and finally other structures may revert to a fetal condition, and white cells resembling fetal cells may be found in the blood stream, especially in cases of tumors involving marrow.

Könnecke,[4] by injections of nucleinate, and von Decastello and Krjukoff,[5] by injections of gelatin, have suggested that the degree of polynuclear leukocytosis caused by these substances furnishes an indication of the functionating ability of the marrow. From our study of this procedure we feel we gain some information concerning the functionating ability of the marrow in regard to its ability to form and send into the circulating blood leukocytes, but not necessarily information concerning the functionating ability of the marrow as a whole.

Increase of the blood platelets in the peripheral blood is also indicative of an increased activity on the part of the marrow supplying the blood platelets. The size, shape and character of these elements is probably also important in determining the activity of the marrow.

When the marrow is functionating above or below normal the three main elements are not necessarily equally affected. The effect may be entirely or predominatingly on one or two of these elements. It is thus necessary in studying the degree of bone marrow activity to consider not only one but all the factors involved.

We have followed our cases of blood disease in their spontaneous course and after treatment especially from the point of view of the degree of bone marrow activity.

4. Könnecke: Deutsch. Arch. f. klin. Med., 1914, cxv, 177.
5. Von Decastello and Krjukoff: Med. Klin., 1911, vii, 225, 267.

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Our, as well as other, previous studies have shown that while the amount of destruction of red corpuscles in pernicious anemia is somewhat reduced as a rule after splenectomy, yet this reduction occasionally occurs without therapy. The spontaneous course of the disease is so irregular and variable that it cannot be denied that it is possible to parallel the reduction of the destruction of the red cells after splenectomy with similar reductions without any treatment. Yet it seems probable that the destructive agents are modified to some extent after splenectomy. It is certain, however, that the destructive processes involving the red cells are still present.

Our fifteen cases of pernicious anemia subjected to splenectomy, in accord with other reported cases, show that the important features of the disease, namely, the typical blood picture and relapses with marked destruction, still persist. As von Decastello[6] and others have pointed out, it is possible to attribute improvement to an increase in blood formation as well as to a decrease in blood destruction. We have, therefore, submitted our cases of pernicious anemia to a critical study of the effect of splenectomy on the blood-forming organs with a view of determining if possible the value of this procedure in altering the activity of the bone marrow.

Fifteen cases,[7] which include all of the patients with pernicous anemia operated on by splenectomy at the Massachusetts General Hospital, were studied (from November, 1914, to May, 1916). Ten of these patients were operated on by one of us (Vincent). The other five were operated on by Dr. C. A. Porter, to whom we are indebted for the privilege of including the operative findings of his cases.

One patient with a red count below 1,000,000 died the day after operation, presumably of postoperative shock. There were no other immediate postoperative

6. Von Decastello: Deutsch. med. Wchnschr., 1914, xl, 639, 692.
7. Lee, Vincent and Robertson: The Journal A. M. A., July 17, 1915, p. 216, reported five of these cases.

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deaths, thus giving an immediate operative mortality of 6.6 per cent. The low immediate mortality indicates that with the proper selection of the time of operation in the course of the disease any considerable operative mortality is not to be expected.

Of the fourteen patients who survived, the operation in one case was too recent to afford any data. Of the remaining thirteen patients, one, operated on two and a half months ago, remains in the hospital on account of thrombosis. The other twelve left the hospital three to six weeks after operation, at which time the large majority presented no great change in their blood counts, and they all felt better, looked better, and were less yellow. In all of them the blood picture was that of pernicious anemia. Four patients showed considerable immediate and progressive improvement in the red counts and hemoglobin. Two of the four were transfused, one two days before, the other two days after operation. None of the other patients were transfused within ten days of operation.

The condition of these thirteen patients was ascertained as far as possible two months after operation. Three could not be said to have changed materially, particularly in their blood counts. One case showed a slight increase and one a moderate increase in the red cells. Eight showed a marked increase in the count of red cells. The red counts of these eight cases averaged approximately 4,000,000, with a corresponding improvement in their clinical condition. Nevertheless the diagnosis of pernicious anemia could be made from the blood films.

Of the thirteen patients, there were ten in whom six months had elapsed since operation. At the end of six months five of these ten patients had a relapse. Four of these five at the two months' period had presented very marked improvement. The fifth patient never showed any great improvement.

At the end of a year after operation we had received no information concerning two patients. These two

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patients had no relapse within six months. Two patients still alive had not yet gone a year after splenectomy. The patient who presented no improvement at the end of the second month period and was relapsing at the sixth month period was dead within a year after operation. Of five remaining patients, only one had certainly gone a year without a relapse. This patient, however, suffered a typical relapse and died sixteen months after splenectomy. One of the remaining four died sixteen months after operation in his second relapse. Another after sixteen months is now having a very serious relapse after several minor relapses. Still another is having his second serious relapse at the end of the year period. The last patient to be accounted for at the end of the year period had a relapse at six months. He was markedly improved by transfusion, and now has 3,000,000 red corpuscles.

The end results of splenectomy certainly fail to show any permanent results from this procedure.

The eventual progress of the disease is not changed. Nevertheless, it is striking that there was in eight out of thirteen cases a considerable temporary improvement in two months, which persisted in some cases to six months. This improvement was marked though not necessarily more marked than the improvement often seen occurring spontaneously; but it seemed to occur rather uniformly after this procedure.

The formed blood elements derived from the bone marrow have been followed in these fifteen cases. Observations on these elements are presented below.

Leukocytes.—Immediately after splenectomy, as has been the usual experience of others, we observed a leukocytosis, varying from 10,000 to 35,000, with increased polymorphonuclear percentage. This occurred within twenty-four hours after splenectomy and subsided within a few days. As pointed out by Cabot,[8] the white count varies with the progress of

8. Cabot: Modern Medicine, Osler and McCrae, 1913.

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the disease, being higher when the number of red cells is higher. We found, as have others, that persistently after splenectomy there was a distinct tendency to a higher level of the white count than occurred in the usual course of pernicious anemia, in which there is usually a leukopenia with often an absolute diminution of polynuclear leukocytes. This increase was both lymphocytic and polymorphonuclear. Perhaps more often there is a relatively greater polymorphonuclear than lymphocytic increase. The polymorphonuclear cells, when increased, tended to give a normal Arneth picture, as contrasted to the abnormal right handed shift which is the usual picture in the spontaneous course of this disease, as pointed out by Briggs.[9] Occasionally a slight eosinophilia occurred.

In general, the leukocytosis immediately after splenectomy and the level of leukocytosis for some weeks afterward contrasted with the average before operation gave a rough index of the future reaction in the red cell forming part of the bone marrow. The patients with the highest leukocytosis tended to show the greatest improvement after splenectomy. Per contra, the patients who showed only a slight increase after splenectomy eventually showed little improvement after this procedure. Such figures do not definitely prove this, but they strongly suggest that a persistently very low polymorphonuclear count in this disease is of value as one of the indicators of bone marrow exhaustion. Under such conditions little improvement is to be expected from any therapeutic measures directed at increasing the activity of the bone marrow.

Platelets.—The number of platelets in pernicious anemia is usually low. Like the leukocyte count, the number of platelets tends in general to follow the curve of the red cells in the usual course of the disease. The platelets show a definite increase three to seven

9. Briggs: Am. Jour. Med. Sc., 1914, cxlviii, 413.

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days after splenectomy. This increase usually takes the platelets not only above the average count in pernicious anemia, but often well above the normal, in one of our cases even to 900,000. This increase is usually persistent, though fluctuations occur. Besides the increase in platelets, there are changes in their morphology. A tendency to abnormally large platelets occurs in pernicious anemia. After splenectomy the presence of a considerable number of very large platelets is striking. There also seems to be an abnormal variation in shape. Like the increase in the white count, the platelet increase seems to be of some value as an indicator of the ultimate reaction of the bone marrow in forming red cells. Likewise, a persistently low platelet count in pernicious anemia seems to be one of the criteria of bone marrow exhaustion.

In this connection we have been impressed by the association of the increase of platelets and thrombosis. Thrombosis is not an uncommon complication of splenectomy. It has been reported as a postoperative cause of death. Of course the platelets are not the sole factor in thrombosis. The immediate and directly exciting cause may be infection or some unknown agent. We have noted thrombosis or phlebitis in three of our cases.

In one case it was noted on the fifth day after operation and involved many veins. In the second case it was noted after three weeks. In the third case it was first observed when the patient reported at nine months. In a case of splenectomy in pernicious anemia of Dr. W. S. Thayer, studied by one of us,[10] thrombosis was noted on the ninth day. In this case extensive thrombosis was the cause of death. In our second case of thrombosis a severe gastro-intestinal disturbance was present on the tenth day, although the phlebitis was not evident until the twenty-first day. All of these cases had at the time of the phlebitis a very

10. Minot, Denny and Davis: Arch. Int. Med., 1916, xvii, 101.

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large increase of platelets. The majority of our other patients had some days after operation, at the time of marked increase of the blood platelets, vague gastro-intestinal symptoms of varying severity. These symptoms were unlike any that they had had before operation and furthermore were quite different from the gastro-intestinal symptoms, so common after any abdominal operation. The association of this condition with thrombosis or phlebitis of some of the mesenteric veins is possible. This association is of course not proved. It may not be amiss to point out that thrombosis in the usual course of pernicious anemia is extremely rare, but apparently is not uncommon after splenectomy. We are inclined to believe that the thrombosis is in some way related to the marked increase of platelets.

Howell-Jolly Bodies.—There occur in the red cells, particularly after splenectomy, and in other conditions often associated with grave anemia, certain round bodies known as Howell-Jolly bodies. The nature of these bodies is not clearly understood, although they are fairly generally assumed to be nuclear fragments. We were able to find a very few of these bodies in three of our cases before operation. It is probable that these Howell-Jolly bodies could have been found in the other cases if the blood had been subjected to a similar prolonged search. They occurred constantly in every case after operation. These bodies usually appeared in small numbers the day after splenectomy, and gradually increased. In some instances 25 per cent. of the red cells contained them. The usual percentage was from 2 to 10. Their percentage fluctuated, but they were always present in fair numbers as long as we made observations. Their morphology varied considerably; there occurred differences in regard to size, situation in the red cells, multiplicity, and their association to reticulated and polychromatophilic cells. We are unable at present to correlate positively variations in number or type with the clinical progress of the

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disease. We are inclined to agree with the general belief that in some way these bodies are related to an increase of bone marrow activity or irritation, or possibly to some change of threshold of output of red cells.

Blasts.—Ten of the eleven cases on which we have adequate data presented within a few days after operation, like other reported cases, a shower of blasts of varying degree. The maximum number of blasts seemed to occur approximately two to ten days after operation. The duration of the blast crisis varied widely and in a few cases persisted for some weeks. The intensity of the reaction in blasts could not be anticipated by the preoperative number of blasts in the blood. The blood of one patient who presented a large number of blasts after operation showed a very rare blast on repeated examinations over a long period of time before operation. It has been our experience that a shower of blasts often precedes a spontaneous remission. This remission may be quite transitory and slight. However, a shower may be seen just before death. After operation a shower of blasts, especially when persistent, seemed to be associated with an ultimate improvement. The findings were not constant and we do not feel that the presence of blasts even in considerable numbers at any stage of the disease including after splenectomy is of much significance as to the future course of the disease.

Reticulated Red Cells.—The percentage of reticulated red cells may perhaps be taken as a measure of the hemopoietic activity of the bone marrow. Normally, about 0.8 per cent. of the red cells are reticulated. In the spontaneous course of pernicious anemia one sees wide fluctuations in the percentage of these cells containing a "reticulum" vitally stained with brilliant cresyl blue. This percentage varied in our cases, from 0 to 20. A high percentage of reticulated cells probably indicates an increased activity of the part of

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the bone marrow that produces red cells. This increased activity of the bone marrow is not necessarily accompanied by either a rise in the count of the red corpuscles or in clinical improvement, since this may or may not be counterbalanced by an increased destruction. Likewise, in the event of decreased activity of the bone marrow, an associated decrease in the blood destruction may leave the number of the red cells and the clinical picture unchanged. In order to form any estimation of the bone marrow activity, as indicated by the reticulated cells, it is necessary to make continuous observations over periods of time. Occasional observations are of no value, as they may indicate only transitory tendencies. However, our data show that curves plotted from frequent observations are reliable indicators of bone marrow activity and are the forerunners of increased red cell counts and of clinical improvement in the absence of excessive blood destruction.

Some studies, as yet incomplete, of the character of the reticulated cells, not only in pernicious anemia, but also in other conditions, strongly suggest that the character of these cells is at least as important as the percentage in determining the intensity and permanency of the bone marrow activity. We consider of particular importance the presence of heavy, knotted reticulum, usually in the center of the cell. Such a reticulated cell is found in fairly large numbers under the recognized conditions of very active blood regeneration, as we have seen persistently in hemolytic jaundice and temporarily after direct hemorrhage in normal persons.

Other characteristics of these reticulated cells that seem to us of probable significance are the size of the reticulated cell, the hemoglobin content, the amount, quality, granulation, and distribution of the reticulum. Also of doubtful significance in regard to bone marrow activity is the presence, which we have noted in a few cases, of the hemoglobin-free reticulated cells or

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bodies, resembling those described by Rous and Robertson, which they consider as probably red cells in the stage of destruction. We are inclined to believe that when the red cells contain a few scattered, short strands of reticulum, particularly when arranged in the periphery of the cell, the actual percentage of reticulated cells is of slight significance.

In general, two to five days after splenectomy in pernicious anemia we found a slight temporary rise in the reticulated cells. These findings coincide with the blood findings at the time of discharge from the hospital about three weeks later. At that time the red count was usually not much increased, but in the event of a persistent increase of the reticulated cells we found marked clinical improvement associated with an increased red count. This was particularly marked in the two patients on whom blood transfusion was performed at the time of operation. In these patients this rise persisted and reached in eight to twelve days a level of about 15 per cent. of reticulated cells, chiefly of the knotted centrally-placed type. In the event of a short and slight temporary rise in the reticulated cells, if an increase in the red count developed later, there first appeared a second and this time a considerable rise in the reticulated red cells. This rise was usually evident about three weeks after splenectomy and was often associated with a shower of blasts. With the appearance of a definite remission, when the red cells approached normal, the reticulated red cells fell to normal figures or lower, with the removal of the necessity of abnormal bone marrow activity.

The degree of the response varied. Those cases in which increases of reticulated cells had been observed either in the spontaneous course of the disease or after transfusion usually showed greater increases after splenectomy. However, we were able to observe increases in reticulated red cells after splenectomy in two cases in which no essential increase in reticulated red cells had previously been noted, either

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in the spontaneous course or after transfusion. These increases tended to be relatively slight, since in such instances it is probably safe to assume that we are dealing with an exhausted bone marrow, apparently incapable of reacting to anything except the strongest stimulation, that is, the changes, whatever they may be, that take place after splenectomy. Two patients in severe relapse after splenectomy have shown a truly remarkable blood picture of bone marrow reaction following transfusion. This was not seen in three others.

The increased reacting power of the bone marrow under the influence of transfusion in the first two cases seems to be related in some way to the absence of the spleen.

The further study of the blood films stained by Wright's stain showed only the characteristics that have been noted previously by us and others. Our observations on polychromatophilia, anisocytosis and stippling have furnished little additional evidence as to the functionating ability of the bone marrow.

While the presence of blasts and of Howell-Jolly bodies is in some way related to the activity or change in threshold output of the bone marrow, we are unable to correlate definitely our data concerning them and those of the reticulated red cells. The reticulated cells furnish the most reliable data concerning the activity of the erythrocytic elements of the bone marrow. The increase in the platelets and the polynuclear leukocytes after splenectomy in pernicious anemia furnishes further evidence of the effect of this procedure in stimulating the bone marrow of these cases.

It is to be noted that splenectomy in pernicious anemia has in nowise a specific stimulating effect on any one portion or on any one function of the bone marrow. It apparently acts grossly on all portions, though the effects are seen at different periods of time in relation to the operation. We attribute the temporary improvement in pernicious anemia after splenectomy to two factors: first, an associated diminution

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in the blood destruction; and second, the associated increase in activity of the bone marrow. We do not attempt to explain the precise mechanism by which splenectomy brings about an increased activity of the marrow. Certain stimulating effects after splenectomy are seen almost immediately, as in the case of the increase in the polymorphonuclear leukocytes. The increase in the platelets tends to occur somewhat later, and the main increase of the reticulated cells, when it occurs, seems to be inaugurated still later. This effect on the part of the bone marrow which forms red cells is much more difficult to bring about and also is slower.

While in general one assumes that the changes in activity of the bone marrow is induced by some unknown irritating or stimulating process, it is possible to explain certain features on other grounds. It may be that, as Naegeli[11] has suggested, we have the threshold of output changed so that cells normally present in the bone marrow but not in the blood may appear in the peripheral circulation. Perhaps the spleen normally may have some inhibitory effect on the bone marrow. On the latter basis it is hard to explain the considerable leukocytosis, similar to that occurring in certain infections, the increase of platelets, and the occurrence at necropsy in pernicious anemia of a red bone marrow. In favor of this assumption one may point to the appearance of Howell-Jolly bodies and certain other characteristics of the red cells that cannot be positively related to such characteristics of the red cells as reticulation, which are generally assumed to indicate, not only the earlier appearance of these cells, but also an actual increase in the formation. It seems probable that both these considerations play a part in the changed picture. We use the term stimulation of the bone marrow in the general sense of indicating the inauguration of the changes.

11. Naegeli: Blutkrankheiten und Blutdiagnostik, Leipzig, 1912.

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By the use of these methods we conclude that one finds stimulation of the bone marrow in pernicious anemia frequently occurring spontaneously. One may find stimulation of the bone marrow usually associated with improvement after transfusion and after splenectomy. Splenectomy seems to result in the greatest stimulation of the bone marrow of any known therapeutic measure. It acts on the whole bone marrow and not only on the portion that forms red cells. However, splenectomy does not alter the essential course of the disease. While more constant stimulating effects are seen after splenectomy, yet we can roughly parallel any individual case of bone marrow stimulation after splenectomy with a case of bone marrow stimulation that occurred either spontaneously or after transfusion.

It is evident that from splenectomy one can attain stimulation but once. Transfusion, while perhaps of less constant and of less active effect, has two great advantages. It is relatively simple and can be repeated a number of times. Transfusion does not modify the destructive agencies at work in pernicious anemia. These considerations must be carefully weighed in advising any therapeutic procedures in this disease.

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LATE RESULTS OF SPLENECTOMY IN PERNICIOUS ANEMIA

A STATISTICAL AND CRITICAL REVIEW *

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The striking improvement that has been shown to follow removal of the spleen in such diseases as hemolytic jaundice and Banti's disease has naturally led to an extension of this clinical procedure to allied conditions. In 1913 three investigators, Eppinger,[1] Decastello[2] and Klemperer,[3] working independently, applied splenectomy to the relatively common and grave disease, pernicious anemia. It is interesting that Eppinger was led to adopt this procedure by observing after splenectomy a diminished output of urobilin and other evidences of decreased hemolysis. Decastello, on the other hand, had noted the improvement that followed splenectomy in the related conditions, hemolytic jaundice and Banti's disease; whereas Klemperer was influenced by the clinical observation that splenectomy for such conditions as rupture of the spleen was in some instances eventually followed by polycythemia.

Such marked improvement was noted in these earlier cases that the procedure was quickly and widely repeated, chiefly in Germany and in this country, so that a fairly large group has already become available for study. More prolonged observation, however, has showed that besides a considerable mortality from the

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1. Eppinger, H.: Berl. klin. Wchnschr., 1913, xxix, 2409.
2. Decastello, A. von: Deutsch. med. Wchnschr., 1914, xl, 639; later reports by personal communication to the author.
3. Klemperer, G., and Hirschfeld, H.: Therap. d. Gegenw., 1913. liv, 385.

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operation and postoperative complications, very few of the patients continue steadily to improve; in almost all the characteristic blood picture of pernicious anemia remained, and not a few died from relapses of the disease in the first year or two after operation. The object of this paper is to ascertain as far as possible by a correlation of the published reports, with later results obtained by personal communication, just how valuable splenectomy has thus far proved to be in pernicious anemia.

Although it has been impossible to get additional reports from some of the German authors, and of some patients who have been lost sight of, nevertheless the results obtained in the last two and one half years are sufficiently concordant to give evidence of some value. In drawing conclusions from any such review, however, it must be remembered that certain difficulties are unavoidable. For instance, the dividing line between pernicious anemia and some of the other primary blood diseases is necessarily such a shadowy one that the possibility of an incorrect diagnosis must always be borne in mind. Then, too, the concept of pernicious anemia varies so much with different authorities that cases included as such by one author might easily be rejected by another. Thus one of the earlier cases of splenectomy that was followed by marked and long-continued improvement, when subjected to critical analysis, seems to the writer rather a case of acquired hemolytic jaundice than of true pernicious anemia. In another case reported as pernicious anemia, the diagnosis was later changed to hemolytic jaundice on account of the subsequent appearance of acholuric jaundice with diminished resistance of the erythrocytes. As such variations in diagnosis are apt to include less serious diseases under the head of pernicious anemia, or diseases in which splenectomy is already known to be of benefit, the present statistics will be correspondingly favored by such inclusions. In applying the present figures to

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prognosis, however, it is fair to offset the inclusion of such cases with the results that must inevitably follow the better selection of cases and better preparation for operation. A third consideration is that the term pernicious anemia may later be found to include more than one clinical entity. (Compare the great variations that occur in the size of the spleen, in the bone marrow reactions, in the evidences of hemolysis, and in the duration of the disease.) If this were found to be true, it might well be that some of the apparently discordant results that have been observed after splenectomy are due to the fact that the operation was of value in one or more types and contraindicated in the others. The results of these studies are included in Table 1.

ANALYSIS OF RESULTS

From Table 1 it will be seen that of the 153 individuals whose spleens were removed, thirty died within six weeks, presumably from the effects of the operation, a mortality of 19.6 per cent. Of the remaining 123 patients, all but twenty-four showed a distinct improvement, both in general condition and in blood picture. Of the twenty-four individuals that survived the operation but failed to improve, a few were obviously harmed by it. To this group belongs Pappenheim's case, splenectomized at a favorable time, when the patient was entering a remission. The condition, nevertheless, was aggravated by the operation, the blood showed signs of increased destruction and a serious relapse began. The improvement noted in the majority of cases lasted varying periods. Thus at the end of six months, of fifty-three patients who had survived operation for more than six weeks and were still under observation, forty-four had still continued to improve and none had died, but nine had already relapsed.

At the end of the first year after operation, there remained twenty-seven patients who were still under observation. Of these, Decastello's series is the most

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TABLE 1.—RESULTS OF SPLENECTOMY IN PERNICIOUS ANEMIA

Observers	References	Number of Cases	Postoperative Results			Total Deaths
			Deaths	No Improvement	Improved	
Decastello, A. von	Deutsch. med. Wchnschr. 1914, xl, 689	12	4	1	8	7
Eppinger, H.	Berl. klin. Wchnschr., 1913, xxix, 2409	7	0	0	7	7
Fahreus, M. B.	Svensk. Läk. Förhand., 1915, viii, 249	3	1	0	2	2
Fenckel	Verhandl. d. deutsch. Gesellsch. f. Chir., 1914, xliii, 233	2	0	2	0	1
Flörcken	Verhandl. d. deutsch. Gesellsch. f. Chir., 1914, xliii, 231	2	1	0	1	1
Frangenheim	Sitz. d. allg. Aerzt. Ver. z. Köln, München. med. Wchnschr., 1914, lxi, 1760	2	1	1	0	1
Giffin, H. Z.	Personal communication to the author	31	3	6	22	7
Guleke	Verhandl. d. deutsch. Gesellsch. f. Chir., 1914, xliii, 227	2	2	0	0	2
Hansing, W.	Med. Klin., 1914, x, 1544	2	2	0	0	2
Hossli, H.	Cor.-Bl. f. schweiz. Aerzte, 1914, xliv, 1171	2	1	0	1	1
Klemperer, G.	Therap. d. Gegenw., 1913, liv, 385	14	4	2	8	5
Lee, R.	The Journal A. M. A., July 17, 1915, p. 216; personal communication to the author	15	1	4	10	3
Longcope, W. T.	Personal communication to the author	2	1	1	0	1
Percy, N. W.	Surg., Gynec. and Obst., 1915, xxi, 360; personal communication to the author	19	2	2	15	4
Roblee, W. W.	The Journal A. M. A., March 6, 1915, p. 796; personal communication to the author	2	0	0	2	1
Roemer	Berl. klin. Wchnschr., 1914, li, 669	2	0	0	2	1
Thayer, W. S.	Tr. Assn. Am. Phys., 1914, xxix, 489; personal communication to the author	2	0	0	2	1
Vogel, C.	Personal communication to the author	7	3	1	3	4
Jagic, N. von	Wien. klin. Wchnschr., 1914, xxvii, 1536	3	0	0	3	0
Single cases[4]		21	4	4	13	9
Total		153	30	24	99	58

4. The single cases were reported by various authors as follows:
Anschutz: Verhandl. d. deutsch. Gesellsch. f. Chir., 1914, xliii, 232.
Baldwin, J. F.: Med. Rec., New York, 1915, lxxxvii, 230.
Brill, N. E.: Tr. Assn. Am. Phys., 1915, xxx, 547.
Buerger, L., and Ottenberg, R.: Med. Rec., New York, 1914, lxxxvi, 860; later report by personal communication to the author.
Coleman, W.: Tr. Assn. Am. Phys., 1914, xxix, 470.
Dahl, R.: Hygiea, 1914, lxxvi, 471; later report by personal communication to the author.
Harpole, W. S.: Surg., Gynec. and Obst., 1914, xviii, 243; later report by personal communication to the author.
Huber, O.: Berl. klin. Wchnschr., 1913, L, 2179; later report by personal communication to the author.
Judell: Personal communication from Dr. Moffitt to the author.
Mann, A. T.: Journal-Lancet, 1915, xxxv, 294.
Moffitt, H. C.: Am. Jour. Med. Sc., 1914, cxlviii, 817.
Mosse, M.: Berl. klin. Wchnschr., 1913, L, 2088.
Muhsam, R.: Deutsch. med. Wchnschr., 1914, xl, 380.
Pappenheim, A.: Deutsch. med. Wchnschr., 1914, xl, 412.
Penrose, C. A.: South. Med. Jour., 1915, viii, 879.
Pepper, O. H. P., and Austin, J. H.: Arch. Int. Med., July, 1916, p. 131.
Port, F.: Berl. klin. Wchnschr., 1914, li, 546.
Rodman, J. S.: Personal communication to the author.
Stewart, F. T.: Personal communication to author.
Talley, J. E., and Jopson, J. H.: Personal communication to the author.
Turk, W.: Deutsch. med. Wchnschr., 1914, xl, 371.

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important, not only because he and Eppinger were the first to try this procedure and therefore the cases could be followed for a longer time, but because the early successful results have been greatly modified by time. Of six patients at the time of his publication several months after operation, four showed such great improvement that except for the microscopic appearance of the blood they might have almost been considered cured. Two years later, however, two were dead and one was in as poor condition as before operation. Of the other two important early series, Eppinger's and Klemperer's, it has proved impossible to get additional information. The figures for the whole group of twenty-seven cases, however, show that the initial improvement has been maintained in less than half of the cases.

TABLE 2.—LATE RESULTS AFTER SPLENECTOMY IN PERNICIOUS ANEMIA

	After One Year	After Two Years
Number cases known	27	6
Still improved	11	3
Relapsed	7	2
Died subsequently	9	1

A small but interesting group is formed by six individuals that have been known to have lived two years or more after operation (Decastello 2, Giffin, Harpole, Huber, Thayer). Of these, Giffin's patient had had the disease for two and a half years; the anemia was not extreme at the time of the operation, and the spleen was much enlarged (1,640 gm.). Improved by the operation, he died three years later from pneumonia. In Decastello's two cases the disease had existed for less than a year, the anemia was severe, and the spleen but slightly increased in size. Both patients improved after operation both clinically and as to the blood picture; but whereas one in a subsequent report was in poor condition, the other was without symptoms, although the blood picture was

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still that of pernicious anemia. Harpole's patient was known to have had pernicious anemia for two years, and at the time of operation the anemia was moderately severe and the spleen twice the normal size. After splenectomy there occurred immediately an active bone marrow reaction with marked clinical improvement. The patient has continued in fair health, with only a slight anemia, but with persistence of spinal cord symptoms. Huber's patient, who was considered moribund at the time of operation, improved rapidly for seven weeks, relapsed, and later underwent a spontaneous remission. After two and a half years, she was still in good condition and able to do her housework, but still anemic. Thayer's patient, having had the disease one year, improved after splenectomy, although there was no bone marrow reaction. After eighteen months the patient relapsed to the same condition as before operation and was last reported in poor condition.

Estimation of the value of such a procedure as splenectomy in pernicious anemia must take into consideration not only the actual results obtained, but a comparison, as far as is possible, with the probable results if operation had not been undertaken. Thus, whereas we have seen that splenectomy caused a quick and marked improvement in 64 per cent. of all patients, natural remissions occurred at one time or another in over 80 per cent. of the patients of Cabot's[5] series treated by the older conservative methods. One cannot maintain from this that perhaps the improvement after splenectomy was only a coincidental remission, because the onset of improvement was too closely and constantly related to the postoperative period; but it does offer some basis for the contention that other methods of treatment may yield results as striking as those following splenectomy. However, from the aspect of duration of the disease the evidence is more

5. Cabot, R. C.: Modern Medicine, Ed. 2, iv, 639.

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in favor of the splenectomized series. In Cabot's series, almost half died in the first year of the disease, and of the remainder, one third died in the next year. As the duration of the disease in the splenectomized series had already averaged one and a half years before operation, they should be more properly compared with the remainder of Cabot's group. By the end of the first year conditions in the splenectomized group were as follows: Of thirty-three patients surviving the operation, twenty-four were still improved, three had failed to show improvement or had relapsed to their preoperative condition and six had died. If postoperative deaths, however, were to be included, only about half of those whose fate was known were still

TABLE 3.—RESULTS ACCORDING TO AGE OF PATIENT, BASED ON ONE HUNDRED AND TWENTY-ONE CASES

Age, Decade	Number Cases	Postoperative Results			Subsequently Died
		Deaths	Not Improved	Improved	
3d	8	2	1	5	1
4th	23	4	2	17	2
5th	43	5	2	36	8
6th	28	4	5	19	6
7th	9	5	2	2	1

alive at the end of the first year. From both these points of view, therefore, there are no clear indications as to the value of splenectomy.

The changes in the blood picture after splenectomy are striking and fairly constant. Forty-seven cases are stated to have had a distinct postoperative blood crisis (appearance of normoblasts, megaloblasts, reticulated erythrocytes, Jolly bodies, etc., in larger quantities); and as statements that the blood crisis failed to appear are very rare, it is fair to assume that such a phenomenon is at least a frequent occurrence. In most of the patients who recovered the stimulation forms soon grew fewer in number and coincident with the signs of general improvement the hemoglobin and red cell count rose. The color index, however, usually remained high. As might be expected, also,

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the nucleated forms became fewer or disappeared; and yet statements are almost unanimous that the microscopic features of the blood (tendency to macrocytosis, poikilocytosis, etc.), even in many cases that showed almost normal counts, remained suggestive of pernicious anemia. Those patients who died within the first six weeks after operation showed either very slight increase in the blood picture or an actual deterioration; whereas death occurring after that period was in many cases preceded by a distinct improvement in the blood picture with the usual signs of a remission.

TABLE 4.—RESULTS ACCORDING TO DURATION OF DISEASE, BASED ON NINETY-FIVE CASES

Duration	Number of Cases	Postoperative Results			Subsequently Died
		Deaths	Not Improved	Improved	
Under 6 months.....	17	4	..	13	...
Six mos. to 1 year.....	26	4	3	19	3
One to 2 years.....	36	3	6	27	8
Over 2 years.....	16	6	1	9	4

Those few patients who up to the present time have continued well after operation must also be taken into consideration. By the older methods of treatment, Cabot in the first edition of Modern Medicine stated that six out of 1,200 cases after six years of health might be said to have been cured. In the second edition this number was reduced to three. May it not develop that a larger percentage of such "cures" will follow splenectomy, even though the blood picture does not return absolutely to normal? Another point brought out by study of the blood picture at the time of operation is that if the operation is undertaken before the blood has reached an extreme degree of deterioration, not only is the operative risk lessened, but the improvement is greater and more lasting. In any case it is wise to precede it with one or more transfusions.

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The average age of the patients at the time of operation was 45; the average duration of the disease at that time 1.6 years. Sex has not been found to exert any influence on the results. If the results are analyzed in groups subdivided according to age, it appears (as one would expect) that less favorable results are obtained in patients in the sixth and seventh decades. A similar arrangement on the basis of duration of the disease, shows that the best results are obtained (after the operation has been successfully passed) in those patients who have had the disease for less than one year.

When arranged according to the degree of anemia at the time of operation, one fact is patent, that the operative risk is much greater in those cases in which hemoglobin is below 20. This is, of course, for this disease, a lower level even than that of one million erythrocytes.

Except for this point, on account of the great fluctuations in blood counts incident to the disease and following transfusions, it is difficult to estimate whether or not the previous condition of the blood has any marked effects on the result obtained. The impression is gained, however, that the best results follow splenectomy in those cases that are not extremely anemic at the time of operation and that have shown considerable fluctuations in the blood picture.

Information as to the size of the spleen was secured in eighty-nine cases. In twenty-eight cases (31 per cent.) the spleen was either small or approximately normal in size. In forty-one cases (46 per cent.) the spleen was slightly enlarged (between 250 and 500 gm.); and in twenty cases (23 per cent.) it was considerably enlarged. In other words, although seldom palpable before operation, it was distinctly enlarged in over two thirds of the cases. If the results of splenectomy are subdivided according to the size of the spleen, it will be seen that better postoperative results were obtained in the cases with enlarged spleens. The

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third group in this arrangement, however, is the only one that could be said to have fared better than another as regards the ultimate outcome of the disease.

THE EFFECT PRODUCED BY SPLENECTOMY

Whatever the cause of the distinct improvement after splenectomy in those patients who survive the operation, it is obvious that it is not due to the removal of the sole cause of the disease. If Eppinger's theory of thickened arteriole walls in the spleen with consequent damming back and destruction of red cells in the splenic pulp were correct, removal of the spleen should indeed cure the disease; but our studies show that this

TABLE 5.—RESULTS ACCORDING TO PREOPERATIVE DEGREE OF ANEMIA, BASED ON ONE HUNDRED AND FOURTEEN CASES

Hemoglobin	Number of Cases	Postoperative Results			Subsequently Died
		Deaths	Not Improved	Improved	
Below 20	9	7	1	1	...
Below 30	29	6	2	21	8
Below 40	38	2	2	29	7
Above 40	43	7	7	29	5

is not the case. On Eppinger's theory, also, the characteristic remissions of pernicious anemia would be difficult to explain.

The postoperative blood crisis discussed above, and the subsequent improvement in the blood picture, decrease in urobilin, etc., indicate both that a stimulus has been applied to the bone marrow and that a source of blood destruction has been removed. Lee's findings of an increased number of platelets after splenectomy would also support the bone marrow stimulation theory. Hypotheses to explain these phenomena have been unsatisfactory and the relevant experimental evidence often contradictory. Klemperer believes that the bone marrow activity is induced by removal with the spleen of an inhibiting hormone, but from experiments in our laboratory we have found (in normal

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animals, to be sure) not only that this bone marrow activity does not occur until after several months have elapsed (Pearce and Pepper[6]) but also that fresh splenic extract stimulates instead of inhibiting the bone marrow (Krumbhaar and Musser[7]). The cause for the blood crisis, therefore, must probably be sought elsewhere; perhaps, as has been suggested, in bone marrow stimulation from metabolic products or from abnormal constituents of the erythrocytes that are allowed to remain in the blood by the removal of the spleen (Decastello). It is also difficult to prove that the lessened hemolysis after splenectomy, as shown by decrease output of urobilin, is actually due to the absence of the spleen. Neither normal spleens nor those removed at operation in cases of blood disease (Coleman, Stewart) can be shown to possess demonstrable hemolytic activity, and studies of the blood entering and leaving the spleen have also failed to throw light on this supposed function of the spleen (Krumbhaar and Musser[7]).

Another factor to be considered is changes in the red blood cells themselves. In one case that I had an opportunity to study (Stewart's), the resistance of the erythrocytes was distinctly increased after splenectomy, so that this might constitute one of the factors of improvement after operation. A similar increase in the resistance of the erythrocytes has been found after the removal of the spleen in normal animals (Pearce and Karsner[8]) and in other blood diseases, but has been denied in some cases of pernicious anemia (Moffitt).

Whatever the cause of the improvement, it is highly probable that the subsequent deterioration is due to other related structures taking over the functions of the spleen (hemolymph nodes, accessory spleens, Kupfer cells in the liver, and perhaps ordinary lymph nodes), although here also no positive evidence has as

6. Pearce, R. M., and Pepper, O. H. P.: Jour. Exper. Med., 1914, xx, 19.
7. Krumbhaar, E. B., and Musser, J. H.: Jour. Exper. Med., 1914, xx, 108.
8. Pearce, R. M., and Karsner, H.: Jour. Exper. Med., 1912, xvi, 769.

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yet been produced. Assuming that the cause of the disease has not been removed, the logical sequence would be that when these auxiliary organs have sufficiently developed, the interrupted course of the disease would be resumed.

As to the few patients who up to the present time have continued well after operation, if the curative action of splenectomy is denied, one must assume either that the causative factor has for reasons unknown ceased to operate, or that the auxiliary organs have failed to develop into pernicious activity.

INDICATIONS FOR SPLENECTOMY

In what cases of pernicious anemia, then, should splenectomy be undertaken? One of two lines may be followed, and it is as yet too early to say which, if

TABLE 6.—RESULTS ACCORDING TO SIZE OF SPLEEN, BASED ON EIGHTY-NINE CASES

Size of Spleen	Number of Cases	Postoperative Results			Subsequently Died
		Deaths	Not Improved	Improved	
Normal or diminished	28	9	5	14	2
Slightly enlarged.....	41	5	4	32	9
Considerable enlarged	20	1	1	18	3

either, is correct. If splenectomy merely induces a remission, and this is at present the opinion of the majority of observers, it should be logical to undertake it only as a last resort, when all other measures have proved unavailing, and only with the hope of prolonging life. Even under such limitations, however, the procedure has already proved its value, and in several cases moribund patients have been brought back to life of comparative well-being for many months. Assuming, on the other hand, that an occasional patient may be, for practical purposes, cured of the disease, and giving due weight to the view that greater and longer continued improvement is obtained if the operation is performed before the disease has reached its final stage, it would then be advisable to undertake it

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as soon as possible. Another factor that may prove to be decisive is whether or not increased hemolysis can be proved. In those cases with clinically enlarged spleens, icteroid appearance and increased urobilin output, without increased resistance of the erythrocytes, the prognosis is distinctly more favorable than in the opposite types. The condition of the bone marrow is also important, splenectomy being contraindicated if the bone marrow is persistently aplastic. It has also been a matter of clinical observation that those individuals in whom spinal cord symptoms have already developed are less apt to be helped by the operation.

CONCLUSIONS

1. Of the 153 patients studied, 19.6 per cent. died within six weeks; a distinct improvement in the clinical condition and in the blood picture occurred in 64.7 per cent., and no improvement in 15.7 per cent.

2. The rather high postoperative mortality (practically 20 per cent.) may be due to poor choice of cases in the early series. As a much greater proportion of the more recent cases has survived the operation, the true postoperative mortality is probably much less than 20 per cent.

3. Of the individuals who showed improvement shortly after operation, nearly two thirds of the total number, a large number have failed to maintain this improvement, or have since died in a relapse or from intercurrent disease.

4. Although a few have continued in good condition during the period of observation (over two years), in no case can it be said that a cure has been effected, and the blood of these individuals continues to show many of the characteristic signs of pernicious anemia.

5. On account of the improvement that follows splenectomy, it would appear to be not only a justifiable, but in many cases an advisable, procedure; but in no case should a cure be promised or the operation undertaken except under the most favorable conditions.

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6. The best results are obtained if the operation is preceded by one or more transfusions, and those patients who relapse after operation may still be greatly helped by transfusion. Whether or not transfusions would have produced equally good results in the absence of splenectomy is a question that cannot at present be decided.

7. The most favorable results may be expected in individuals who have not passed the fifth decade, in whom the disease has not progressed for more than a year, and who have a relatively good blood picture, (that is, an anemia that is not of too extreme a degree or of the steady, progressive type). Individuals with enlarged spleens have done better than those in whom the spleen was small or of normal size, as have also those suffering from an anemia characterized by excessive hemolysis.

8. The opposite of these conditions should be considered as unfavorable factors, as should also the existence of spinal cord symptoms or the presence of an aplastic bone marrow.

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SPLENECTOMY IN SPLENIC ANEMIA, HEMOLYTIC ICTERUS AND HANOT'S CIRRHOSIS

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The value of splenectomy in splenic anemia remains unquestioned, and since the first report by Banti in 1894 sufficient time has now elapsed to enable us to draw definite conclusions regarding not only the immediate success, but also the permanency, of the results. Within recent years two other conditions resembling in many clinical aspects splenic anemia have been relieved and probably permanently cured by splenectomy, namely, hemolytic icterus, both of the acquired and congenital type, and the hepatic cirrhosis of Hanot. These three conditions, splenic anemia, hemolytic icterus and the cirrhosis of Hanot, have many things in common and no doubt in the past have been frequently confused.

In all there is marked enlargement of the spleen, although the literature contains a few reports of apparently true hemolytic icterus without palpable splenic tumor. In all three conditions there is chronic anemia or chronic icterus, or both. Evidence of obstructive icterus is always lacking, and when jaundice is present the patients do not show certain toxic manifestations, as bradycardia and pruritus, so common in other forms of jaundice. While typical hemolytic crises occur in only hemolytic icterus, sudden, unaccountable increase in the anemia is not infrequent in Banti's disease. Hemolytic icterus often occurs in several members of a family and may be definitely hereditary.

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While familial cases are much less frequent in splenic anemia, they nevertheless occur; in fact, the Gaucher's type of splenomegaly, which must be classed with splenic anemia, quite frequently takes this form; and Brill, Bovaird Collier and others have reported two or more cases of splenic anemia in the same family, and White reports 104 cases of splenomegaly with anemia from South China, where he states the condition is common and is often a family disease. To show the close relation between these two conditions, Chauffard and Troisier report a case in which the mother of the patient had hemolytic icterus, the son had an enlarged spleen with anemia and no icterus, but with urobilin in the urine and lessened resistance of the red corpuscles. The writer recently saw an apparently typical case of hemolytic icterus, but without enlarged spleen, the patient reporting that his sister had a large spleen, which had been removed, but she had never suffered from icterus.

Chronic jaundice is constantly present in hemolytic icterus and Hanot's cirrhosis, but it is infrequent in splenic anemia. Osler reports its presence in only four of his twenty-six cases, and Griffin in two out of eighteen cases. Great enlargement of the liver is constantly present in Hanot's cirrhosis, and a very decided enlargement of the liver is not infrequent in hemolytic icterus. Osler, in sixteen cases of splenic anemia, reports moderate enlargement of the liver in six, and in one the liver was very decidedly enlarged.

The chief point of difference in these three conditions is the lowered resistance of the red corpuscles in hemolytic icterus. This finding, however, is not constant and its absence should not interfere with the diagnosis of hemolytic icterus in the presence of other evidence. Normal resistance of the erythrocytes has been reported in two cases by Hopkins, two by Lommell, one by Claus and Kalberlak, all of these being of the familial type. Morse reports two and Banti one of the acquired form. Türk states that in splenic

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anemia the resistance of the red corpuscles may be increased or diminished, and Eppinger reports three cases, all with increased resistance. In Hanot's cirrhosis, as in other forms of chronic icterus, the resistance of the red corpuscle is increased.

In hemolytic icterus bile is usually present in the blood, but there is no urobilin; while in the urine bile is absent except during hemolytic crises, but urobilin is present. This peculiar condition is not present in either of the other two diseases.

Secondary anemia of greater or less degree is characteristic of splenic anemia and hemolytic icterus, but is not present in Hanot's cirrhosis.

Urobilin in the stool, usually considered as an index of blood destruction, is greatly increased in hemolytic icterus. Eppinger believes that the amount present in the normal stool is from 0.12 to 0.15 gm., while in three patients with hemolytic icterus the amount varied from 2.25 to 3.8. Eppinger and Robertson have each determined the urobilin in the stool in Hanot's cirrhosis and they find it varies little from the normal. Eppinger has reported on two cases of Banti's disease, the amount of urobilin being 0.32 and 0.33 gm., respectively, a rather moderate increase above the normal and often reached in various conditions, as, for instance, in cardiac incompensation. That blood hemolysis is not especially important in splenic anemia is further supported by the relatively small amounts of iron found in the liver, spleen and kidneys in this condition. There is also no evidence that blood hemolysis is active in Hanot's cirrhosis, while in hemolytic icterus excessive blood destruction is very evident.

In these three conditions, which are in many ways so closely related, it is at present impossible to explain why in Hanot's cirrhosis there is icterus without anemia, in splenic anemia there is anemia without icterus, and in hemolytic icterus there are both icterus and anemia, although in many instances icterus is the dominant condition.

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Splenic Anemia.—The majority of modern writers question whether we have in splenic anemia a disease entity. It is quite probable that in the past some patients with hemolytic icterus were diagnosed as having splenic anemia. It is also quite likely that at present splenomegaly of varied etiologic origin is included in this group. Banti's original definition included only those cases of anemia with enlarged spleen in which known etiologic causes could be excluded. It is not improbable that a chronic splenic tumor from any cause, especially if this enlargement is associated with great increase in the endothelial cells, which have been shown to have a marked erythrolytic activity, might give rise to chronic anemia. That in such cases splenectomy might be curative is also probable. Gaucher's splenomegaly may be given as a type of splenic anemia. Clinically, it conforms satisfactorily with our conception of splenic anemia. The histologic condition of the spleen, however, places it in a distinct class. Especially in children splenomegaly from syphilis with anemia may also be included, at least clinically, as splenic anemia. Chiari and Marchand report evidence of syphilis in some patients with clinically diagnosed splenic anemia coming to necropsy. Caronia applied the Wassermann test to the parents of thirty children with splenic anemia and reported it positive in nineteen. Curshmann reports the case of a patient with a history of hereditary syphilis who clinically had splenic anemia, recovery occurring after salvarsan. Mayo refers to three patients in whom syphilis may have been the cause.

In somewhat the same manner the enlarged spleen in a case of cured malaria might take on an increased erythrocytic function and thus give clinically a splenic anemia. Bey reports three cases, two corresponding to the first stage of Banti's and one to the third stage, that cleared up completely under quinin. In all of these there was a definite history of malaria. Throm-

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bosis of the splenic or portal vein, with stenosis, may also give rise to clinical splenic anemia, as in the case reported by Warthin and Dock.

The classification of all splenic tumors with chronic anemia under the general head of splenic anemia may not be logical, but from a therapeutic point of view such a grouping may be desirable, as there is indisputable evidence that cure has been effected in the vast majority of patients clinically diagnosed as having splenic anemia, on whom splenectomy was performed. Even when the disease had advanced to the point of marked hepatic cirrhosis and ascites, more or less complete return to normal has been reported.

The results of operative measures in the early stage of the disease are excellent. Griffin, from the Mayo Clinic, reports the cases of five patients, three with cirrhosis and ascites, and two in the preascitic stage of cirrhosis, on whom splenectomy was performed, and four of the five returned to normal health. One of these patients with ascites has been well seven years. In the Mayo series of eighteen patients, two died, or 11 per cent. Twelve of the sixteen recovering from the operation are now in excellent health (1915); two are definitely improved; one at first improved, later developed ascites and died, and one died two years after the operation, the cause of death not being determined. Some have advised against splenectomy during the ascitic stage, but the literature contains several reports, in addition to those already referred to, of the disappearance of ascites after splenectomy and the permanent cure of the patient. As operation is the only means that offers hopes of cure in this disease, it should be undertaken, provided the condition of the patient is not such as to make recovery from the operation improbable.

Regarding the mortality from splenectomy, the figures of Mayo have already been given, 11 per cent. in eighteen cases. This represents the lowest reported operative mortality in a relatively large series of cases.

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In the thirty-six cases reported by Banti, in which splenectomy was performed, the mortality was 44.4 per cent. Fifty-seven cases from various sources between 1900 and 1909 gave a mortality of 19 per cent., and in sixty-one cases reported since then the mortality was the same. This may probably be taken as the average mortality. In addition to the reported cures of splenic anemia by mercury and quinin, distinct benefit has been observed in a number of cases through the use of the Roentgen ray. There is no definite evidence, however, that any of these have been permanently cured.

Hemolytic Icterus.—Minkowski in 1900 was the first to describe this condition as a distinct disease. Appearing either as an acquired or familial condition, the first symptoms may develop either at birth or during early adult life. The characteristic symptoms, outside of its familial nature, are the chronic icterus of fluctuating intensity, combined as a rule with varying degrees of anemia; greatly enlarged spleen, often moderately enlarged liver, urobilin in the urine, but no bile except in some instances after a hemolytic crisis; the stools well colored, with no evidence of biliary intoxication, as pruritus and bradycardia, and the presence usually of a lowered resistance of the red corpuscles. The disturbed resistance of the erythrocyte, which has been considered so characteristic of this condition, is not always present. Banti, Claus, Morse, Lommell and Hopkins have reported cases of both the hereditary and acquired types with normal corpuscular resistance. Even absence of a splenic tumor has been observed by Banjamin and Sluker, Marchiafavas and Nazarios, and the writer has recently seen a case of this character.

As a rule the patient is little inconvenienced by his trouble, so that Türk has referred to it as a cosmetic disturbance, rather than a disease. Probably too much stress has been placed on the benign character of the trouble, as the majority of these patients suffer from

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anemia and consequent lowering of their efficiency. Especially following a hemolytic crises, the occurrence of which is so common in these cases, the degree of anemia may be so great as to temporarily incapacitate the individual. In a case recently observed the hemoglobin fell during a crisis from 85 to 40 per cent., the patient developed a temperature of 105 and for two days was delirious. It is true that the degree of inconvenience observed varies greatly; some are apparently not the least disturbed by their condition, others are always under par. Symptoms, when present, are due to the anemia, and not to the icterus. When considering the advisability of splenectomy, the degree of inconvenience caused by this trouble should be seriously considered, as the operation is attended with a certain amount of danger and should not be undertaken without definite indications.

The usual presence of lowered resistance of the erythrocytes and the relation of the spleen to this phenomenon stamp hemolytic icterus as having a probable etiologic relation to the spleen. The hemolytic function of the normal spleen was first described by Kolliker in 1847, and Balbi in 1893 reported that splenectomy increased the resistance of the red corpuscles. In 1895 Banti demonstrated that in dogs after splenectomy pyradin did not cause icterus. This work has been confirmed by a large number of observers — Pel, Paton and Goodall, Pearce, Heinz and others. It might be considered that as the normal spleen tends to lower the resistance of the erythrocyte to hemolytic agents, an enlarged or hyperfunctioning spleen might increase this tendency to such a degree that hemolysis would occur from a variety of mildly hemolytic agents normally present. It is possible in these cases, however, that the enlarged spleen may not be the cause of the disturbed resistance of the erythrocyte, as it is well established that this disturbed resistance is not always present. Furthermore, while as a rule the resistance of the corpuscles soon returns to normal

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after splenectomy, there are several cases on record in which this failed to take place. A notable case of this kind is seen in the patient operated on in 1887 by Sir Spencer Wells, in whom, as reported by Dawson, the red corpuscles still showed lessened resistance in 1914. Roth also reports a case in which three and one-half years after splenectomy the corpuscles hemolyzed in 0.6 per cent. salt solution. It is possible these patients may have developed accessory spleens. Küttner reports a case in which necropsy, made eleven years after splenectomy for gunshot wound, revealed the presence in the peritoneal cavity of eighty to one hundred spleens. Significant, however, is the fact that in spite of the disturbed resistance of the erythrocyte these patients after the splenectomy have remained well, showing that the spleen is responsible in some way for the hemolysis, even if not concerned in the lowered resistance of the red corpuscles.

Splenectomy is undoubtedly curative. Although Micheli in 1911 was the first to perform splenectomy in recognized hemolytic icterus, several patients wrongly diagnosed as having splenic anemia had been previously splenectomized with permanent cure. In this list might be mentioned Banti's case in 1904, Umber's in 1904, Burghard and Sutherland's in 1906, and Roth's in 1908. Since Micheli's case the number of reported splenectomies has grown rapidly. Elliott and Kanavel in 1915 collected in the literature forty-eight cases. The operative mortality in these forty-eight cases was only 4.1 per cent., surprisingly low. The forty-six patients who recovered from the operation were cured. The jaundice rapidly disappeared, beginning within a few days, and as a rule being complete within two weeks. The recovery from the anemia was somewhat slower, but relatively rapid. The hemolytic crises ceased, although Elliott and Kanavel report a crisis in their patient fifteen days after splenectomy. As only five years have elapsed since Micheli's case, it might be said that time has been too

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short to insure permanency. In the list of permanent cures, however, may be included those cases already referred to in which splenectomy was performed under a different diagnosis. As none of these patients have relapsed, we are justified in saying the results are permanent.

Parisot and Huelly in 1913 report two cases of hemolytic icterus cured by the Roentgen ray; the permanency of these results cannot be confirmed. With our knowledge of this condition it is reasonable to believe that the Roentgen ray may be beneficial.

Hanot's Cirrhosis.—True Hanot's cirrhosis is a rare disease. Like splenic anemia, mistaken diagnoses are probably frequent. That it bears some resemblance to splenic anemia and hemolytic icterus must be admitted. For this reason it is not surprising that a cure should follow splenectomy. Eppinger in 1913 reported two patients cured and Mayo recently reported one. As far as I have been able to determine, these are the only reported cases. It would appear probable, however, that in Hanot's cirrhosis, a condition which has heretofore been considered incurable, splenectomy was indicated.[1]

1. Those interested in consulting the literature on this subject will find a very complete bibliography on both splenic anemia and hemolytic icterus in the following artcles:
Krumbhaar: Analysis of Clinical Types of Splenomegaly Accompanied by Anemia, Am. Jour. Med. Sc., 1915, cl, 227.
Elliott and Kanavel: Splenectomy for Hemolytic Icterus, Surg., Gynec. and Obst., 1915, xxi, 21.

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SPLENECTOMY FOR HEMOLYTIC JAUNDICE

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The past few years have shown a great increase in the interest manifested by American surgeons in the surgery of the spleen. Splenectomy has been demonstrated to be a safe and effective means of curing certain diseases (for example, Banti's disease), and is extensively employed in other conditions in which its ultimate benefit still has to be proved by a more prolonged study and report of late results.

Among the conditions which seem to be promptly and permanently benefited by splenectomy is the group of so-called hemolytic jaundice cases, which occur in two forms, the congenital and the acquired.

The accumulating evidence of the results of splenectomy has proved the etiologic relation of the changes in the spleen to the disease. The former hypothesis of essential hemolysis must be abandoned. What the exact nature of the process may be is still more or less obscure, but that the spleen plays the most important part is certain. The constant presence of urobilin and urobilinogen in the urine is simply an evidence of the destruction of the hemoglobin molecule in the process of hemolysis, and these substances disappear soon after splenectomy is performed.

No bile is found in the urine unless there is a complicating disease of the biliary tract. This complication has been noted many times.

In the congenital group we have the well-recognized familial type, in which heredity plays such a striking part, and also congenital cases, in which no family his-

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tory exists, but in which the jaundice appears at birth or in early infancy and persists throughout life or until relieved by operation.

The acquired type forms another distinct clinical group, the symptoms of which closely follow those of the congenital type. We have had three typical cases in patients on whom splenectomy has been performed in the second surgical division of the Roosevelt Hospital, since May, 1912, when the first case to be reported came under my care. The patient, a young woman, aged 30, of the congenital, nonfamilial type, was the first patient on whom splenectomy was performed for congenital hemolytic jaundice in this country.

Her history was as follows:

F. N. (history No. B2654), a married woman, aged 30 years, on May 6, 1912, was admitted to the second surgical division of the Roosevelt Hospital, transferred from the medical service of Dr. Evan Evans. Her only complaint was a mild degree of persistent jaundice, she being otherwise healthy. She was one of a family of eleven, her father, mother, three brothers and seven sisters being alive and well. None of them had ever been jaundiced, nor was there a history of jaundice in any branch of her family. She was the first child, born at full term in normal labor. Jaundice was first noticed when she was 3 days old, and this had continued all her life. She had measles, mumps and whooping cough as a child, but no other illnesses. Her appetite was good, she slept well, took plenty of exercise and drank no alcohol, and coffee and tea only moderately.

The jaundice was present in mild degree with no other symptoms until she was about 21 years of age, when she first had an attack of deepening of the jaundice. Since that time similar periodic attacks (acholuric crises) have occurred, with a general tendency to deepening of the jaundice, but with no other symptoms. She has never had itching, slowing of the pulse, or any of the symptoms which accompany an ordinary obstructive jaundice.

In July, 1907, in Baltimore, cholecystostomy was performed, but no gallstones or other lesions of the biliary tract were found. Jaundice returned and persisted as before as soon as the biliary fistula healed.

On January 22, 1909, two and one half years after the cholecystostomy, she was admitted to the Johns Hopkins Hospital, and was under observation by Dr. Thayer for about two weeks. A diagnosis of congenital hemolytic jaundice was made by Thayer,[1] who did not advise operation. Her

1. Thayer and Morris: Bull. Johns Hopkins Hosp., 1911, xxii, 85.

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red cell fragility tests at that time were practically identical with those taken by us three years later. Thayer stated in his comments that "in congenital hemolytic jaundice recovery is unknown, but some improvement may be obtained by persistent treatment with iron." Pathologic changes in the spleen and splenomegaly were recognized, but their definite relation to the etiology of the disease was not appreciated, and the cause of the fragility and increased hemolysis was thought to reside in the blood itself. From Jan. 26 to Feb. 11, 1911, she was in a hospital, in New York, again for the jaundice. A diagnosis of congenital stenosis of the common duct was now made, but operation was not advised. From July 16 to Aug. 14, 1911, she was under treatment in the same hospital, ill with typhoid fever, and from August 18 to September 12 she was back with a relapse.

The persistence of the jaundice so preyed on her mind that on March 5, 1912, she was again operated on, at the Roosevelt Hospital, first surgical division, in the hopes of finding calculi or some lesion of the biliary tract. No calculi were found, and no lesion of the gallbladder or ducts; a few whitish spots on the surface of the left lobe of the liver were seen, and one was excised for examination. It showed simply anemic, degenerated liver cells. The operation was a simple exploration. On April 10, 1912, she was readmitted to the Roosevelt Hospital, medical division, service of Dr. Evans. Careful studies were made by Dr. Evans and Dr. Mortimer Warren, pathologist to the hospital, whose report, which follows, covers the periods before and after splenectomy.

The jaundice was general, of a moderate degree, lemon yellow in color, lacking the greenish tinge of obstructive jaundice. The edge of the spleen was 4 to 6 cm. below the costal margin.

Urobilin was present in the urine, but no bile. Bile was present in the feces, which were of normal color. The Wassermann reaction was negative.

Blood examination showed hemoglobin 63 per cent., red blood cells 4,400,000, and white blood cells 8,000. The differential count showed polymorphonuclears 65 per cent., lymphocytes 20.5 per cent., large mononuclears and transitionals 10.5 per cent., eosinophils 3.5 per cent., and basophils 0.5 per cent. The red cells were small and of good color, and there were no nucleated red cells. Plates were abundant. About 20 per cent. of the red cells showed postvital reticulation. Five fragility tests taken between March 16 and April 22, 1912, before splenectomy, showed, as an average, a minimum resistance of 0.72 per cent., and a maximum resistance of 0.27 per cent. On May 9, two days after splenectomy, test showed a minimum resistance of 0.72 per cent., and a maximum of 0.36 per cent. Four tests taken from May 13 to May 25, 1912, six to eighteen days after splenectomy, gave as an average a minimum resistance of 0.50 per cent.,

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and a maximum of 0.32 per cent. Test made Sept. 9, 1912, four months after splenectomy, gave a minimum resistance of 0.48 per cent. and a maximum of 0.30 per cent. Test Oct. 8, 1915, three years and five months after splenectomy, showed a minimum resistance of 0.40 per cent. and a maximum of 0.35 per cent. The hemoglobin, which was 65 per cent. two days after splenectomy, reached 80 per cent. on June 7, 1912, one month later. The red blood cells, at first slightly reduced, were about normal. Red blood cells showing postvital reticulation appeared only in moderate (normal) numbers after operation. On May 9, 1912, two days after splenectomy, examination showed leukocytes 30,000, polymorphonuclears 80 per cent. On Oct. 9, 1912, four months after operation, examination revealed leukocytes 11,000, polymorphonuclears 53 per cent., lymphocytes 22 per cent. Examination of blood Oct. 18, 1915, three years and five months after operation, gave as a result, hemoglobin 95 per cent., red blood cells 4,204,000, white blood cells 13,000, polymorphonuclears 58 per cent., lymphocytes 30.3 per cent., transitionals 7.9 per cent., eosinophils 3.6 per cent., with plates abundant. The red blood cells showing postvital reticulation were 0.5 per cent.

On the advice of Drs. Evans and Warren, and in the belief that pathologic changes in the spleen were responsible for the excessive hemolysis, and possibly for the fragility of the red cells, splenectomy was performed on May 7, 1912. There were no adhesions, and the operation was technically simple and well borne.

The spleen was only moderately enlarged, weighing 360 gm. and measuring 19 by 12 by 6 cm. Gross section showed no evidence of pathologic change beyond congestion, except for the presence of numerous light-yellow, firm nodules from 1 to 4 mm. in diameter. The surface was roughened with many light-colored pinpoint spots scattered over the surface.

Microscopic examination showed marked congestion, with much of the blood interstitial. There was no marked increase in fibrous tissue. The arterioles appeared thickened, and nodules were noted in areas of sclerosis, showing with proper stain remains of elastica. They were, therefore, sclerosed arterioles, possibly the result of typhoid. Follicles were somewhat crowded out.

A diagnosis was made of congestion of the spleen, chiefly interstitial. Except for a mild, left-sided pleurisy, with effusion, which developed on the sixth day and lasted about a week, convalescence was uninterrupted. Diminution in the jaundice could be definitely noted on the third day after operation, and by the tenth day, for the first time in her life, she was entirely free from jaundice, and has remained so ever since. The prompt and permanent disappearance of the jaundice, together with the great improvement in the red cell resistance, has been most satisfactory.

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This case presents several striking features, among which was the marked degree of fragility of the red cells before operation and their prompt return to the normal after splenectomy, a result which has been by no means uniform in the reported cases. Another was her rather checkered surgical experience, owing to the fact that her treatment coincided with the developmental stage of our knowledge of the condition, and of the etiologic relation of the diseased spleen to it. As Chauffard so aptly remarks, "she was more icteric than sick," but in spite of this fact, the presence of the jaundice and the feeling that she was different from other healthy women so preyed on her mind that she persisted in her efforts to find a cure for her malady.

The case presented the characteristic findings of hemolytic jaundice, as described first by Hayem[2] in 1898, by Chauffard[3] in 1907, and by Elliott and Kanavel[4] in their interesting case of the familial type. and many other careful observers, namely, persistent, nonobstructive jaundice without itching, slowing of the pulse or the presence of bile in the urine; paroxysmal exacerbations of the jaundice, at times accompanied by dull, aching pain in the upper abdomen; chronic splenomegaly of a moderate degree; secondary anemia of a moderate type; fragility of the red cells of a very marked degree, with complete return to the normal after splenectomy; increase in the number of reticulated red cells to 20 per cent., which fell to normal (0.5 to 1 per cent.) after splenectomy; the presence of urobilin and urobilinogen in the urine.

The second case was of the acquired type, of short duration, the patient having had symptoms for only nine months preceding the operation. As has been previously noted in this type, the onset of the jaundice was ushered in by an acute illness, accompanied by fever, after which the jaundice persisted and increased in degree without the occurrence of definite crises.

2. Hayem: Presse méd., 1898, i, 121.
3. Chaffard: Semaine méd., 1907, No. 3, p. 25.
4. Elliott and Kanavel: Surg., Gynec. and Obst., 1915, xxi, 21.

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In contrast to the preceding case, the red cell fragility in this case was not very marked, and did not change perceptibly after splenectomy. The vital stain reticulation of the red cells reached 16 per cent. and dropped to normal after operation. The secondary anemia was moderate in degree, the hemoglobin and red cell count approaching the normal soon after operation. Auto-agglutination tests were negative, as in Michelis' case, in contrast to the experience of Widal, Abrami and Brulé,[5] who found it constantly positive in the acquired type, and absent in the congenital and familial types. Urobilin and urobilinogen were present in the urine, and the feces were normal in color and contained bile. Splenomegaly was pronounced, the spleen weighing 800 gm. Splenectomy was followed by a prompt disappearance of the jaundice and a complete return to health.

An abstract of this patient's history follows, and further detailed studies of the case have been published by Dr. G. A. Friedman, from whose service at the Vanderbilt Clinic he was referred to me for operation.

M. T. (history No. B7036), an Italian, a single man 18 years of age, was referred from the Vanderbilt Clinic early in November, 1915, where he had been carefully studied by Dr. G. A. Friedman, who made a diagnosis of acquired hemolytic jaundice and advised splenectomy. Except for diseases of childhood, the nature of which he did not know, the patient had had no previous illness. He had come to America from Italy eighteen months before. Jaundice was first noted about nine months before he came to the hospital, and had been persistent up to the time of admission.

Examination showed a rather slender, well-nourished young man, with marked general icterus of a lemon yellow hue. His spleen extended to within an inch of the umbilical level in the mammary line.

The urine contained urobilin and urobilinogen; the feces were of normal color and contained bile and also urobilin.

The blood examination showed a moderate degree of secondary anemia; 78 per cent. hemoglobin; 4,200,000 red cells, with 16 per cent. postvital reticulation, and a normal differential count. Auto-agglutination tests were negative. Two

5. Widal, Abrami and Brulé: Presse méd., 1907, lxxxi, 641.

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fragility tests before operation showed a minimum resistance of 0.48 to 0.50 per cent., and a maximum resistance of 0.30 to 0.35 per cent.

Splenectomy was performed on November 23, 1915, at the Roosevelt Hospital. The gallbladder and ducts, liver, stomach and pancreas were normal. The spleen measured 17 by 10 by 7 cm. and weighed 800 gm. It was slightly adherent along the posterior border and at the upper pole, but delivered without great difficulty and the operation was well borne.

The jaundice began to fade within two or three days and was entirely gone by the tenth day. The patient has remained well and entirely free from jaundice since the operation.

The spleen was rather soft and flabby, the cut surface was dark red and rather granular, and the trabeculations stood out prominently. Microscopically, there was no increase of fibrous tissue; the follicles were of varying size, some having disappeared. There was marked interstitial suffusion with red blood cells. The changes in the pathology of the spleens removed have been fairly uniform and correspond with those found in previous reports. There is marked interstitial suffusion of red blood cells, dilatation of splenic sinuses, loss of follicles and absence of germinal centers. There is practically no increase of fibrous tissue.

Six days after splenectomy the fragility test showed a minimum resistance of 0.50 per cent. and a maximum of 0.35 per cent., that is, there was no change following the operation. On December 20, four weeks after operation, the fragility test was the same, reticulation of the red cells was normal (0.5 per cent.), and urobilin and urobilinogen had disappeared from the urine. The patient gained in weight and resumed his work four weeks after the operation.

This case illustrates the acquired type of hemolytic jaundice, evidently dependent on the splenic changes and on no previous etiologic factor that could be determined.

The fragility of the red blood cells in this case was slight, and was practically unchanged after splenectomy.

The third case was of the congenital, nonfamilial type, and the patient was operated on by my colleague, Dr. James I. Russell, to whom I am indebted for permission to include it in this report. Only a brief abstract of the history will be given, as the case was presented to the New York Surgical Society and reported in its *Proceedings*.

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The patient was a man, 20 years of age, transferred from the medical service to the second surgical division on July 6, 1915 (history No. 6546).

He had been jaundiced since birth, the icterus increasing up to 5 years of age, after which time it was stationary. There was no history of jaundice in the family. He presented the following symptoms: Icterus of a fairly marked degree, nonobstructive in type, of a lemon yellow hue, secondary anemia of a mild type; 74 per cent. hemoglobin, 5,200,000 red cells; red cell fragility not increased, the minimum resistance being 0.45 per cent., and the maximum 0.30 per cent., remaining unchanged after operation; reticulated red cells, vital stain, 8 per cent.; splenomegaly of a marked degree, the spleen weighing 1,143 gm.

Splenectomy was performed on July 10, 1915, and was followed by complete disappearance of the jaundice and a prompt recovery.

In addition to the three cases cited, I have recently performed cholecystectomy for calculi with chronic cholecystitis in a typical case of congenital hemolytic jaundice of the familial type, with marked splenomegaly. Both the patient and her physician were unwilling to have splenectomy performed at that time, though recognizing the possible necessity of such a procedure in the future.

That hemolytic jaundice is not uncommon and that it can be cured by splenectomy are now well recognized, and recent contributions to the literature are emphasizing its importance and bringing it more and more to the attention of the profession.

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INDICATIONS FOR SPLENECTOMY IN CERTAIN CHRONIC BLOOD DISORDERS

THE TECHNIC OF THE OPERATION

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Splenectomy has already proved a curative measure in certain diseases associated with definite blood changes, and the operation has recently been advocated for other diseases which appear to be more or less closely related to those in which the spleen is now the known causative factor. The basis on which splenectomy has been suggested in these heretofore incurable conditions will be more clearly understood if we briefly review the development which has resulted in the present situation.

Splenic anemia offers the most familiar example of the therapeutic value of splenectomy. Sufficient time has now elapsed since the earlier operations for this disease to prove that the results of splenectomy in early or in moderately advanced cases are not only excellent, but permanent. The most interesting characteristic of the disease as concerns the purpose of this paper is its tendency to develop cirrhotic changes in the liver. In fact, Banti described the disease as it appeared in its later stages when it is associated with marked cirrhosis and with ascites. In such a stage, from a diagnostic standpoint, it is often difficult and sometimes impossible to determine in a given case whether the condition is the result of a true splenic anemia or of a primary liver cirrhosis associated with a large spleen. Experience has shown that in the very late stages of splenic anemia definite improvement fol-

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lowing splenectomy cannot be expected, yet it is also true that a moderate cirrhosis, even associated with ascites, has been present in some cases in which excellent results have been obtained. This fact, therefore, with the probability that certain of the cases which have been classified as true splenic anemias and operation performed on that diagnosis, were in reality cases of primary cirrhosis, was responsible for the suggestion that splenectomy might prove of value in arresting the progress of selected types of hepatic cirrhosis.

The interdependence of spleen and liver is not clearly understood, yet there is ample evidence to show that some of the most important functions of the liver, for example, its hemolytic power, are more or less controlled by the spleen. Certain pathologic conditions in the liver, therefore, are the result of overactivity, which may in turn be due to overstimulation by the spleen.

During the last two years, with this theory as a basis, selected patients with primary hepatic cirrhosis have been splenectomized. Two, at least, of four such cases of our own gave promise that the removal of the spleen might stop or retard the progress of the disease, but we are not yet in a position to state the value of such a procedure.

The success of splenectomy in splenic anemia, with associated splenomegaly and severe anemia, has led to splenectomy in other diseases in which splenomegaly and anemia are characteristics. One of the most interesting of these is the syphilitic spleen; we have seen good results follow splenectomy in three cases of this form of syphilis. The prominent clinical features of the cases in which we believed operation to be indicated were (1) splenomegaly, (2) a history of syphilis not responding to treatment, (3) positive Wassermanns, (4) anemia. It is important to note that previous to operation a negative Wassermann could be obtained under appropriate treatment, but the reaction became positive as soon as treatment was dis-

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continued. All these patients had gummas in the liver, and in the spleens removed the spirochete could be demonstrated in large numbers. It was also a clinical observation that although the virulence of the infection could be more or less controlled by antisyphilitic treatment, it was not eradicated.

From the foregoing facts, the conclusion may be drawn that the spleen picks up the spirochetes and harbors them, and this conclusion is supported by the surgical observation that removal of the spleen, followed by antisyphilitic treatment, results in prompt and permanent relief.

The influence which the spleen exercises on the hemolytic function of the liver and spleen is most strikingly illustrated in the effect of splenectomy in hemolytic jaundice. Although this disease is a problem from an etiologic standpoint, the most important therapeutic fact is that splenectomy is followed by prompt, complete and permanent cure. The rapid disappearance of the icterus, which is the most obvious symptom of the disease, is an amazing clinical result; the anemia, which is sometimes severe, is also rapidly corrected.

The remarkable results following splenectomy in splenic anemia and hemolytic jaundice, particularly the latter, appear to have provided the basis on which Eppinger and others have suggested that similar surgical treatment might prove of value in pernicious anemia. It is important, therefore, that the relationship of splenectomy to these other diseases should be borne in mind. The argument becomes more forceful if it is possible to establish similarities between any one of these diseases for which splenectomy is curative, and pernicious anemia. Many of the features of hemolytic jaundice appear to have a counterpart in pernicious anemia, and, in fact, Eppinger believes that the chief, and possibly the only, difference between hemolytic jaundice and pernicious anemia is that in the former the bone marrow is able to com-

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pensate for the increased blood destruction, whereas in pernicious anemia it soon loses this power, and the disease eventually is dependent on a bone marrow disability.

It would, therefore, appear as a logical sequence that since splenectomy has proved a specific in hemolytic jaundice, it would sooner or later be advocated in pernicious anemia. Although the first operations for this disease were performed, both abroad and in this country, about the same time (1913), to Eppinger must be given special credit for efforts to establish a scientific basis for the surgical treatment. While the surgical therapeusis of pernicious anemia can be considered as on trial, it presents features of much interest and promise, and splenectomy is now being performed with a frequency which should soon permit definite and decisive deductions.

It must, of course, be primarily recognized that any new therapeusis in a disease of the character of pernicious anemia must be subjected to a particularly thorough trial. The extreme chronicity of the disease in its usual course, and the fact that, with or without treatment, remissions occur, during which the patient is much improved and the blood may even revert to normal, stamps any conclusions based on the early results of operation as premature. This much, however, can be said, that immediate improvement follows splenectomy more consistently and promptly than any treatment heretofore used.

It is on the ultimate results, however, which are as yet insufficient, that the final decision as to the real efficiency of splenectomy in pernicious anemia must rest. There is at the present time, therefore, decided uncertainty as to any superior therapeutic value of a permanent character possessed by splenectomy. It is also true that pernicious anemia has thus far been an incurable disease, ranking in fatality with cancer and less amenable to successful treatment. The certainty of the ultimate prognosis has been the outstanding

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feature of our knowledge of the disease, and the doomed patient could hope only that the disease would be slowly progressive and not associated with great physical disability.

The pathologic picture which Eppinger has described as distinctive of the spleen in pernicious anemia is as follows: The pulp areas in the spleen, and only these, are gorged with blood. Eppinger explains this engorgement as a direct result of an abnormal condition of the central artery. It has been shown that the entire wall of this artery is greatly thickened, and that the greatest change takes place in the media. The theory is, briefly, that sufficient obstruction results to force the flow of blood through the capillaries into the pulp areas, where the erythrocytes are destroyed. If a constant pathology can be demonstrated in the spleen in pernicious anemia, it will be a great advance toward the rational treatment of the disease.

While it cannot be held that the basis on which Eppinger and his followers have endeavored to establish the surgical treatment of the disease has been confirmed or even well supported by others, it is not essential, nor is it good judgment, to postpone surgical treatment of the disease until an acceptable basis for such treatment is generally recognized.

The hemolytic nature of pernicious anemia is demonstrated by the increased amounts of urobilin and urobilinogen excreted. It has been assumed, and there is much clinical and experimental evidence to show, that this hyperhemolysis is due to a hypersplenism, and interesting investigations are now being conducted, after the suggestion of Schneider, to determine the exact quantity of these hemolytic products by obtaining them immediately with a duodenal tube on their exit from the liver. Giffin has shown, by the records of the urobilin and urobilinogen estimation in a series of cases of pernicious anemia, that the values appeared to run more or less parallel to the degree of icterus, and that in some cases at least there was a marked fall

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in the value of the blood-derived pigments after splenectomy. It is possible that from this method information of at least prognostic value may be derived. Giffin has suggested the very interesting possibility that the relation of hemolysis, as shown by the estimation of the blood-derived pigments, and the bone marrow disability, as illustrated by the blood picture, may result in deductions of decided value.

The effect of splenectomy in other diseases being the primary basis for the operation in pernicious anemia, the further indications must be mainly based on operative results, and as early results only are as yet available, such indications are presented with reservation and will undoubtedly be subject to further modification.

INDICATIONS FOR OPERATION

Size of Spleen.—It would appear that the larger the spleen the better the prospects that splenectomy will prove of benefit. It may be assumed in this disease that oversize means overactivity, and it has certainly been true, in our own experience, that the most consistently promising results following splenectomy have occurred when the spleen showed the greatest enlargement. However, good immediate results have been obtained also when little or no enlargement was present. The palpability of the spleen, therefore, has been looked on as one of the first considerations in discussing the advisability of splenectomy. Exclusive of three cases in which the spleens were very large, the spleens in a series of thirty-seven of our cases averaged 400 gm., as compared with the normal of about 195 gm. It should be remembered that any estimation of the size of the spleen before it has become actually palpable is rather speculative. W. J. Mayo early pointed out that frequently in exploring the spleen in the course of abdominal operations, and comparing its actual size with that noted in the clinical records, it is found that clinical records are not consistently correct and as a rule are accurate only when the organ is palpable.

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Icteric Types of the Disease.—The very intimate relationship between the spleen and the acholuric icterus as seen in pernicious anemia, hemolytic jaundice and in hypertrophic cirrhosis is proved both by operative results and experimental studies. The remarkably rapid, complete and permanent disappearance of the jaundice in hemolytic jaundice, for example, following splenectomy is sufficient evidence of the splenic factor. Experimentally, it is very difficult to produce toxic jaundice in spleenless dogs by those poisons which readily produce it in the normal dog. In spleenless dogs under the administration of such poisons (particularly toluylendiamin) the bile remains thin and green, while in nonsplenectomized dogs it becomes viscid. Stadelmann was the first to attribute such acholuric jaundice to this thickening of the bile, which delays, by very reason of its viscosity, its own passage through the finer bile capillaries. A marked icteric discoloration in the skin in pernicious anemia may be taken as an indication that the spleen is to a large degree responsible for the abnormal blood destruction feature in the disease.

Response to Transfusion.—The transfusion of blood, particularly of small quantities at frequent intervals, has for some time been recognized as valuable treatment, though only of temporary character, in pernicious anemia. It has recently become evident, however, that transfusion is not only an excellent therapeutic expedient, but that in the immediate response following the procedure, it is of distinct prognostic value in foretelling the probable results of splenectomy. Definite improvement after transfusion is a strong indication for splenectomy, but when no benefit occurs from repeated transfusions, splenectomy will probably also prove futile, though the reverse of both these indications is occasionally true. Transfusion seems to serve a double purpose, as does the ligation of the blood supply in exophthalmic goiter, by

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(1) improving the condition of the patient, and by (2) predicting rather accurately the effect of the major operation on the disease.

Duration of the Disease.—Although in our own experience satisfactory results may be obtained when the disease has been of long standing, we believe the results are not as favorable as those in cases in which the disease has existed a short time.

Radical measures to interrupt the progress of the disease while it is yet in an early stage seem logical. Although there is little positive knowledge as to the reason for the permanent disability of the bone marrow, it is probable that it is constantly overstimulated in an effort to meet the abnormal demands made on it, and also suffering from the influence of the hemolytic agent or some other toxin.

In pernicious anemia, like exophthalmic goiter, the course of the disease tends to be interrupted by periods of comparatively good health and normal bodily functions. Each recurrence, however, further damages the organs which are affected by the toxin, and although with the interruption of the process in its early stages there may be complete restoration to health, sooner or later, regardless of the further course of the disease, permanent injury results.

The ability of man to develop other hematopoietic centers, when the normal source of the supply of blood corpuscles, the bone marrow, is under great stress, is well known. Such centers have been demonstrated in the spleen, the liver and lymph nodes. Whether in pernicious anemia the augmentation of the hematopoietic functions is simply compensatory by reason of the increased blood destruction of the disease, or whether the bone marrow, under the influence of some specific toxin, is primarily diseased, so that immature red cells are put into the circulation, is as yet problematic. It is more than possible that pernicious anemia could be cured in its inception, like cancer, if treated properly; when it is well established, a vicious circle is produced

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and a permanently disabled hematopoietic system is added to the primary etiologic factor or factors. The question of permanent cure in pernicious anemia, therefore, may ultimately depend, not only on interrupting the progress of the disease by removing what appears to be the primary factor, but also to a greater extent on our ability to restore the bone marrow and other hematopoietic structures to their normal physiologic functions. It is to be hoped that earlier recognition of pernicious anemia will result in earlier splenectomy.

Activity of the Disease.—The activity of the disease is an important consideration in discussing the advisability of operation. Splenectomy should be undertaken with hesitation in acute stages of pernicious anemia and especially with a falling blood picture. The operation cannot at the present time be advocated when cord changes and other permanent pathologic processes mark the terminal stages of the disease. Moreover, as already suggested, if it is not possible to tide a patient over the critical periods by transfusion, splenectomy is contraindicated. Definite statements based on the qualitative blood picture cannot be made, but if the hemoglobin is under 25 per cent. and cannot be raised, operative treatment is of considerable risk and has doubtful results.

The extent of the disability of the patient must of course be carefully considered. If a patient with every evidence of the disease is able to carry on his usual occupation, splenectomy cannot be strongly advocated, yet these may be the very patients in whom good results may be obtained. The operation may be urged more legitimately when the patient is unable to do his work or is a chronic invalid.

A positive diagnosis of pernicious anemia having been made and the advisability of splenectomy established, it is important that the patient and his family be correctly informed as to the purpose and the status of splenectomy.

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Splenectomy we have found of less technical difficulty in pernicious anemia than in any other disease or condition. An incision toward the outer edge of the left rectus extending above to about one inch from the costal margin and below to the level of the umbilicus is satisfactory. An abdominal exploration should first be made, especially in view of the frequent complications of liver and gallbladder met with in those diseases for which splenectomy is advocated.

The dislocation of the spleen from its position against the diaphragm and against the left kidney is not, as a rule, complicated by formidable adhesions in pernicious anemia; nevertheless, the operation is facilitated and the minor oozing points are controlled by the introduction of a large abdominal pack against the newly exposed surface. In the actual removal of the spleen it must always be borne in mind that the stomach and pancreas are in close anatomic relationship. The fundus of the stomach is in such immediate apposition to the gastric surface of the spleen that its wall may be injured if the gastrosplenic omentum at this point is not divided with particular care.

The tail of the pancreas does not bear a constant relationship to the splenic pedicle. In some instances it lies in front; in others behind, and it may extend along the pedicle until its tip rests in the hilus of the spleen. It is quite evident, in certain cases, that the tip of the pancreas must be dislodged from its position if the pedicle is to be ligated without injury, although such a condition is relatively unusual in pernicious anemia. The pedicle is rarely of sufficient size to present any difficulties in its control. It is comparatively easy to isolate the artery and the veins and ligate them independently. Although it has been advised that the artery should be ligated first in order that the spleen may empty itself of its blood, and although I have done this in some cases, I have never been able to observe any difference in the convalescence or the effect of

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splenectomy on these patients, as compared with those in whom the artery and veins were ligated at the same time.

All bleeding points having been securely controlled, the pack is removed and the diaphragmatic surface inspected.

SUMMARY

We believe that splenectomy should be considered in every case of pernicious anemia in which the diagnosis has been established and all possible etiologic factors which might be independently remedied have been excluded. The failure of other means to combat the disease, the previous fatal prognosis, and the low operative mortality are strong arguments in favor of splenectomy. Contraindications must be positive and adequate. Granting this, however, we must be cautioned by our imperfect knowledge of the surgical indications. The conservative selection of cases is therefore advisable.

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PERNICIOUS ANEMIA TREATED BY SPLENECTOMY AND SYSTEMATIC, OFTEN-REPEATED TRANSFUSION OF BLOOD

TRANSFUSION IN BENZOL POISONING *

ROY D. McCLURE, M.D.
DETROIT

Transfusion of blood in cases of pernicious anemia is perhaps the first remedy that suggests itself for the treatment of the malady. It probably was tried long before it is recorded in the literature. Since the newer ways of transfusion with syringes and the citrate method have so simplified the operation, it has been tried innumerable times, but with only indifferent success. The best it has accomplished has been to initiate a remission in the course of the disease. There are many reasons why these transfusions have not been of more value. Chief among these is the lack of systematic treatment. Usually about as much good is accomplished by a single transfusion as is accomplished by a single inunction of mercury in the treatment of syphilis. Discredit has also been incurred by using blood which has not stood the proper tests and which is not only unsuitable but is often positively harmful and which may result in disaster.

The practice of transfusion of blood since it was first performed in man in 1666 by Jeane Baptise Denys, professor of philosophy and mathematics in the Royal University in Paris and physician to Louis XIV, and by his teacher Dr. Lower[1] in London, who had developed the method by his work with his experi-

* From the Surgical Clinic of Dr. W. S. Halsted, Johns Hopkins Hospital.

1. Philosophical Transactions and Collections of Medical and Philological Papers, John Lowthrop, 1731.

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ments on animals in 1660, has passed through periods of great disrepute. At first it fell into disfavor because the blood of animals, dogs, sheep and calves was used and there were probably deaths from anaphylaxis. The road to safe transfusion was not made possible until Landois[2] in Greifswald in 1870 discovered that the blood of one man was not always compatible with the blood of others, though I believe he never explained it, yet he did show that the serum of one animal might dissolve the red blood cells of another animal. It remained for Moss[3] in this country and for Landsteiner[4] and Jansky[5] abroad to show that the blood from two individuals may not mix well, due to the following facts:

1. That the red corpuscles of one or of each may be clumped by the serum of the other.

2. That corpuscles clumped in this way may be hemolyzed as well.

3. That all human beings soon after birth may be grouped into four distinct classes, depending on the ability of their serum to agglutinate the red corpuscles of members of the other groups and on the susceptibility of their corpuscles to agglutination by the serum of members of the other groups.

In the selection of a donor little attention for a time was paid to the fact that the serum of an individual in one group hemolyzed and agglutinated the cells of a person in another group. Some men doing transfusions wrote as late as 1912 that the action of one blood on another was not necessarily the same in vitro as in vivo, and they rather scoffed at these tests. This attitude could only do harm to the reputation of transfusion as a therapeutic measure. I know that deaths have occurred as the result of transfusion when the tests were ignored or improperly performed. Even when the tests were properly performed and the bloods

2. Landois: Die Transfusion des Blutes, 1875.
3. Moss: Bull. Johns Hopkins Hosp., 1910, xxl, 63.
4. Landsteiner: Wien. klin. Wchnschr., 1901, xiv, 1132.
5. Jansky: Klin. sborn., 1907, No. 2; abstr., Jahresb. f. Neurol. u Psychol., 1907.

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reported compatible, we have had one case of severe hemolysis. On returning to the laboratory tests we found that agglutination was present at the end of one hour, but we had accepted the report as favorable at the end of a half hour. Therefore, we concluded that the report of compatibility can not be safely made under an hour.

In an extended series Moss has found that the relative frequency of the groups is as follows: Group 1, 8 per cent.; Group 2, 36 per cent.; Group 3, 9 per cent.; and Group 4, 47 per cent. Gorham and Lisser[6] found that the serums of the various groups differed in the rapidity with which they brought about agglutination of the corpuscles of the other groups. Thus Group 4 required five minutes or less, Group 2 often fifteen minutes to half an hour, and Group 3 still longer for positive identification.

The selection of a proper donor is therefore a very important matter, and often rather difficult if the patient belongs in one of the rarer groups, 1 or 3. It is also imperative that transmissible diseases be ruled out by history, blood examination, Wassermann, etc. I wish to report here for the first time the transmission of syphilis by transfusion in a case of pernicious anemia. The donor was a close relative of the patient and before giving his blood denied having syphilis and also denied exposure to infection. Less than six weeks after this transfusion the patient returned with the most virulent syphilitic rash and mucous ulcers. At the same time the secondary eruption appeared in the donor. It then developed that the donor had a primary sore at the time he gave the blood. Malaria was transferred in one of the early cases by a transfusion of defibrinated blood. It was in the quiescent stage in the donor, but flared up in the recipient.

Transfusion has usually been carried on in cases of pernicious anemia in a very desultory or sporadic fashion, and as we have pointed out, often without

6. Gorham and Lisser: Am. Jour. Med. Sc., 1912, cxliv, 103.

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proper donor being selected, consequently it was soon regarded as of little value in this disease.

Our attention was first drawn to the great value of repeated transfusions, in 1914, in the treatment of benzol poisoning.

On the service of Dr. L. F. Barker at Johns Hopkins Hospital in 1909 there were admitted the first of a series of cases of benzol poisoning. The patients were girls employed in a canning factory in Baltimore. Benzol (benzene, C_6H_6) was used in dissolving rubber and the fumes resulted in the poisoning of the workers. The symptoms are a severe purpura hemorrhagica with a severe anemia of the aplastic type. Several transfusions were performed among these cases, but as there was only temporary improvement, if any, the procedure was regarded as of little value. Several patients died soon after admission. The following case we report, as the result of each transfusion was so striking, one of the operations so plainly saving her from immediate death. Our previous results had been so discouraging, as the improvement of a single transfusion was so temporary, and we were ready to give up. The family of the patient, however, saw the enormous immediate benefit of each transfusion and insisted that we continue with this treatment. They produced the donors, so we always had suitable blood. Much to the surprise of all of us she soon ceased to require transfusion and made a complete recovery.

S. H., a woman, aged 31 years, worker in a canning factory, admitted to the hospital May 1, 1914, complained of bleeding from the nose and mouth. A diagnosis of benzol poisoning and secondary anemia was made. Her family history was unimportant. Her present illness began with an onset seven weeks before entrance (early part of April, 1914), with a feeling of weakness and bleeding from the nose. The hemorrhage usually lasted from one-half to two hours. Black and blue spots appeared over the body, followed by shortness of breath, bleeding from the gums and loss of appetite.

On examination the woman was found to be pale and obese. There was bleeding from the margins of the gums. There was no general glandular enlargement. The lungs were clear, the heart slightly enlarged. A systolic blow was perceptible

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at the base. Numerous purpuric spots were distributed over the body, and there was slight edema of the extremities.

On May 2, 1914, the red blood cell count was 1,460,000; white blood cell, 1,110; hemoglobin, 25 per cent.; polymorphonuclears, 40 per cent.; mononuclears, 37 per cent.; transitionals, 15 per cent.; no nucleated red blood cells; no myelocytes. Platelets were almost absent. Bleeding time fourteen and one-half minutes; normal time is one-half to two minutes.

Transfusions were done by the Carrel end-to-end method. The results are shown in Table 1.

After each of the first three transfusions she rapidly lost what she had gained and unfortunately another transfusion was not done until she had slipped back. The fourth transfusion was all but too late. A massive transfusion was done, probably 1,500 c.c. or more of blood being given, and there was a great rise in hemoglobin. (We were still using the end-to-end suture method, so no measurement of the quantity of blood could be made.) Normoblasts and nucleated red cells made

TABLE 1.—RESULTS OF TRANSFUSIONS IN CASE OF SECONDARY ANEMIA FROM BENZOL POISONING (SUTURE METHOD)

No.	Date, 1914	Hemoglobin, per Cent.			Red Blood Cells		
		Before	After	Increase	Before	After	Increase
1	5/ 8	20	38	18	1,226,000	1,680,000	454,000
2*	5/17	28	48	20	1,117,000	1,971,000	864,000
3	5/23	20	40	20	910,000	1,856,000	946,000
4†	5/31	11	42	31	0	0	
5	6/13	48	65	17	3,476,000	4,528,000	1,052,000

* Defibrinated blood.
† Patient bleeding, comatose.

their appearance and after the next transfusion (donor a negro man) the patient made an uneventful recovery, and was discharged from the hospital July 26, 1914.

Jan. 17, 1916, the patient has remained well, the hemoglobin being 95 per cent.; red blood cells, 4,272,000.

This led us to believe that perhaps steady use of carefully planned transfusions persistently used to prevent the anemia and its results might be of benefit in pernicious anemia. We advocate, too, splenectomy.

Since Eppinger in May, 1913, first called attention to the very beneficial effect of splenectomy in pernicious anemia, it has been widely performed. American surgeons have reported often great improvement, but probably no cure. It is unnecessary to discuss it further after the papers of this symposium. Eppinger

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regards splenectomy as the most important measure in the treatment of pernicious anemia.

Table 2 shows a brief résumé of our transfusions in pernicious anemia. As will be seen, splenectomy was carried out in only six of these cases, three by Dr. Finney and three by myself.

TABLE 2.—RESULT OF TRANSFUSIONS IN SEVENTEEN CASES OF PERNICIOUS ANEMIA, SIXTY-FOUR TRANSFUSIONS BEING MADE WITH NO DEATHS *

Result	Number	Per Cent.
Beneficial	34	53
No benefit	23	35
Harmful	7	10
Severe reactions	7	10
Slight reactions	12	19
Chill	7	10
Dilated heart 24 hr. after transfusion	1	1½
Jaundiced	1	1½
Hemoglobinuria	3	4½
Temp. elevation over 101	12	19
Skin eruptions	7	10

* Splenectomy was performed in six cases.

The transfusions that resulted harmfully or were of no benefit we feel due to improper matching of the blood. This resulted in still greater care in the selection of donors. In the earlier cases, little benefit resulted from the fact that only a single transfusion was done. We will report only three cases here as there is not space for all.

CASE 1.—T. A., aged 38, was admitted to the hospital Feb. 22, 1915, complaining of progressive weakness. A diagnosis of pernicious anemia and pyorrhea alveolaris was made. The family and personal history were unimportant. The present illness had its onset in June, 1914, with weakness, followed by loss of appetite, constipation, nausea and vomiting, and a loss of weight of 24 pounds. There was dyspnea but no nervous system symptoms.

Blood examination made Feb. 22, 1915, showed red blood cells, 1,584,000; white blood cells, 4,560; hemoglobin, 32 per cent. The color index was high; the differential count, 70 per cent., polymorphonuclears, mononuclears, 25 per cent., 1 nucleated red blood cell.

On Jan. 17, 1916, blood examination showed hemoglobin 93 per cent.; red blood cells 3,728,000; polymor-

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phonuclears 77 per cent.; small mononuclears 10 per cent.

CASE 2.—J. B., a woman, aged 43, was admitted to the hospital, Sept. 10, 1915, complaining of weakness, shortness of breath, and pallor. A diagnosis of pernicious anemia was made. The family history was negative. The personal history of the patient showed that the bowels were regular, and that she had had two miscarriages. Otherwise the history was unimportant.

The patient had had cystitis for two years, appetite poor, with a burning sensation of tongue and mouth. The temperature was from 99 to 101. There had been some dizziness for six months. A roaring sensation in ears had been noticed for two months. There was slight edema.

TABLE 3.—EFFECT OF TRANSFUSIONS ON THE PATIENT T. A., CASE 1

No.	Date, 1915	Amt. C.c.	Hemoglobin, per Cent.			Red Blood Cells		
			Before	After	Change	Before	After	Change
1	3/ 9	700	25	33	8	1,428,000	1,920,000	492,000
2	3/26	750	54	67	13	2,128,000	2,440,000	312,000
3	7/ 3	650	29	40	11	840,000	1,656,000	816,000
4	7/10	675	32	41	9	1,296,000	2,128,000	832,000
5*	7/24	700	35	?	?	1,884,000*	?	?
6	8/ 8	700	29	45	16	?	?	?
7	8/27	700	40	60	20	1,888,000	3,220,000	1,332,000
8	9/ 1	652	50	60	10	1,960,000	3,088,000	1,128,000
9	9/ 3	675	60	70	10	3,088,000	3,144,000	56,000
10	9/ 9	675	60	65	5	2,424,000	?	?
11	9/11	880	65	75	10	2,424,000	3,688,000	1,264,000
12	9/23	770	80	85	5	3,632,000	4,432,000	800,000
13	10/ 7	675	80	90	10	4,928,000	5,280,000	352,000

* Splenectomy was performed following fifth transfusion.

On examination of the patient the mucous membranes were found pale; the blood pressure was 150 mm. of mercury systolic, 80 diastolic; the temperature was 100.4. There was an impaired percussion note at the apexes of the lungs, but no râles. The heart was slightly enlarged. A systolic murmur was heard at the apex. The liver was not enlarged and the spleen could not be felt. There was no general glandular enlargement. The reflexes were normal. The stools were negative.

Blood examination showed hemoglobin 27 per cent.; red blood cells 1,136,000; white blood cells 3,560; polymorphonuclears, 66 per cent.; eosinophils, 0.5 per cent.; basophils, 0.5 per cent.; small mononuclears, 27.5 per cent.; large mononuclears, 3 per cent.; transitionals, 1 per cent.; myelocytes, 1 per cent.; myeloblasts, 0.5 per cent.

On September 12 the hemoglobin was 29 per cent.; white blood cells, 2,000; red blood cells, 944,000. There were fresh

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hemorrhages in both eye grounds. The Wassermann was negative. Gastric analysis showed hydrochloric acid deficit 8 per cent.; total hydrochloric acid 2 per cent.

CASE 3.—H. P., a widow, white, aged 62, was admitted to the hospital Jan. 3, 1916, complaining of weakness and lack of blood. Her family and personal history were unimportant. Previous to her present illness she had always been healthy and strong. The onset occurred in January, 1914. There was increased frequency of urination. A few weeks later there was weakness of the knees, progressive shortness of breath, and for three weeks, pain over the heart. There had been no fainting or giddy spells; she had lost 37½ pounds in weight.

Examination showed a woman of large frame, with dyspnea on slight exertion. There was a lemon color to the skin, and evidence of recent loss of weight; no general glandular enlargement; teeth practically all gone; chest symmetrical;

TABLE 4.—EFFECT OF TRANSFUSIONS ON THE PATIENT J. B., CASE 2

No.	Date, 1915-16	Amt. C.c.	Hemoglobin, per Cent.			Red Blood Cells		
			Before	After	Change	Before	After	Change
1	9/25	800	20	35	15	680,000	1,520,000	840,000
2	9/30	900	35	45	10	1,664,000	2,048,000	384,000
3	10/ 9	900	55	76	21	2,240,000	3,520,000	1,280,000
4	10/16	900	76	85	9	2,432,000	4,176,000	1,744,000
5	10/24	20	85	52	33*	4,176,000	2,672,000	1,504,000*
6	10/30	900	47	62	15	3,624,000	4,000,000	376,000
7	12/11	788	22	40	18	648,000	2,158,000	1,510,000
8	12/14	900	42	55	13	2,450,000	3,158,000	708,000
9	12/18	800	?	?	?	?	?	?
10	12/21	280	..	48	..	.....	3,000,000	
11	12/30	550	53	48	5*	1,900,000	?	?
12	1/22	500	51	70	19	3,368,000	3,648,000	280,000
13	1/12	660	74	78	4	3,792,000	?	?
14	1/14	270	78	82	4	?	?	?

* Lost, due to hemolysis.

costal angle almost straight. No râles; region of cardiac dulness extended 4.5 cm. to the right and 11 cm. to the left of the midline. There was a systolic murmur at the base of the heart and a diastolic murmur over the vessels of the neck. The blood pressure was 118 mm. of mercury systolic, 60 diastolic. The liver was not enlarged, and the spleen could not be felt. The reflexes were difficult to obtain. There were no sensory disturbances. Rectal examination was negative. Red blood cells were 936,000; white blood cells, 5,440; hemoglobin 26 per cent.; polymorphonuclears 50 per cent.; eosinophils, 0.4 per cent.; basophils, 0.4 per cent.; small mononuclears, 28.8 per cent.; large mononuclears, 2.8 per cent.; transitionals 0.8 per cent.; myelocytes 13.6 per cent.; unclassified, 3.2 per cent.; red blood cells January 7, 1,088,000; hemoglobin 25 per cent.; Gastric analysis showed no free hydrochlorates; stool examination was negative; eye grounds normal except for pallor of

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the disks. January 10, red blood cells 1,288,000; hemoglobin 23 per cent.

The repeated systematic transfusion has been carried out only during the past year. The results, however, have been so encouraging that we feel that the life of a patient with pernicious anemia may be indefinitely prolonged if the spleen is removed as soon as the patient is in condition to stand the operation, and sometimes we have to transfuse several times before splenectomy.

TABLE 5.—EFFECT OF TRANSFUSIONS ON THE PATIENT H. P., CASE 8

No.	Date, 1916	Amt. C.c.	Hemoglobin, per Cent.			Red Blood Cells		
			Before	After	Change	Before	After	Change
					Loss			
1	1/12	200	26	23	3	1,224,000	1,440,000	216,000
2	1/21	300	21	26	5	1,440,000	1,448,000	8,000
3	1/24	682	29	36	7	2,352,000	2,608,000	256,000
4	1/26	640	36	50	14	2,352,000	2,416,000	64,000
5	2/ 2	630	50	55	5	2,416,000	2,434,000	18,000
6	2/ 7	660	54	65	11	3,040,000	4,680,000	1,640,000
7	2/19*	450	65	?	?	2,482,000	2,726,000	244,000
8	2/26	360	68	?	?	3,072,000	?	?
9	3/ 6	500	70	76	6	3,752,000	3,824,000	72,000
10	3/13	450	71	86	15	3,584,000	4,736,000	1,152,000

* Splenectomy was performed February 12.

After the spleen is removed if there is not a rapid improvement in the blood picture, we would advocate transfusion until the hemoglobin is as high as 90 per cent. or more, never allowing it to fall below 75 per cent. As remissions often last several months or a year, not many transfusions may be required. It is well known that anemia so reduces the resistance of the body to infections that it is often an easy prey. Thus can the usual secondary causes of death in pernicious anemia be avoided, and who can tell but that within a few years of persistent transfusions the primary cause, whatever it may be, of pernicious anemia may lose its force and perhaps the disease be cured.

I wish to thank Dr. George R. Dunn for his assistance in preparing the abstracts and tables for this article.

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ABSTRACT OF DISCUSSION

ON PAPERS OF DRS. LEE, MINOT AND VINCENT, KRUMBHAAR, MILLER, PECK, BALFOUR AND MC CLURE

DR. FRANK SMITHIES, Chicago: During the past two and a half years in the clinics of Drs. Percy and Ochsner we have treated twenty-seven cases of pernicious anemia by multiple transfusion of whole blood and splenectomy. Our cases have strongly impressed on us the value of the observations of William Hunter with respect to the toxic or even the infectious nature of the ailment. Just what effect on the hematopoietic tissues may be produced by a periodically recurring low grade infection it is not at present possible to fully state. Of peculiar significance, in my opinion, is the fact that in practically all of our cases, infective foci were demonstrable. The removed spleen showed evidences of chronic splenitis and perisplenitis, indicating that a toxic or infective process had been chronically going on. It has not been possible to culture organisms from the blood or the tissues. It would seem that work similar to that which Rosenow has carried out in tissue culture will at some time demonstrate organisms which at present escape detection. The term "treatment by splenectomy" is, I think, misleading and incomplete. The splenectomy is merely one part of the treatment and frequently a part of the treatment which may perhaps later on be proved to be the least essential. The routine of treatment which we have emphasized is: multiple, massive transfusions of whole blood, eradication of local foci of infection wherever such may exist, and lastly, laparotomy for removal of the spleen and other tissues evidencing chronic subinfection.

Multiple blood transfusions supply protective antibodies and enable the patient to get rid of the secondary changes which have been going on in the various organs. They improve the blood in quantity and quality. They thus bring the patient to his splenectomy as a fair to good operative risk. During the multiple blood transfusion the patient can be treated with regard to self-evident infection. The operative procedure then becomes relatively safe. Of the twenty-seven cases operated on by Dr. Percy there were but two operative deaths, and one other death within three months following splenectomy. I attribute this rather remarkable experience to the fact that the patients were carefully prepared for the major operation. I attribute many of the poor results following splenectomy in pernicious anemia to the patient's being rushed into splenectomy before he has been properly prepared as a surgical risk. Ninety per cent. of the cases which I observed showed subinfections in the gallbladder or appendix and all showed evidences of chronic infection in the spleen.

The effects on the blood in the cases I have studied are: In cases that have run from four to twenty-seven months following our treatment there has been an average hemo-

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globin gain of 43 per cent.; an average gain of red cells of 3,322,000, and this gain has in general been well maintained. Study of blood smears shows an absence or diminution of nucleated red blood cells of 94 per cent. There was a decrease in the color index in 68 per cent. There was a permanent increase in the leukocytes in 88 per cent.; a decrease in coagulation time in 66 per cent.; a decrease in polychromatophilia in 56 per cent., and the establishment of a relative polymorphonuclear leukocytosis in 61 per cent.; a reduction, relatively, in lymphocytosis in 55 per cent., and a definitely demonstrable gain in blood platelets in 61 per cent. Patients frequently improved, clinically, out of all proportion to the apparent improvement in the blood picture. The permanence of these results no one can at present state. One patient treated twenty-seven months ago is in most excellent shape after having been a useless invalid for more than two years previously.

Dr. Beth Vincent, Boston: Transfusion is so often combined with splenectomy in the treatment of pernicious anemia that they may be considered together in discussing the effects of splenectomy. At the Massachusetts General Hospital we always test donor and recipient before transfusion in pernicious anemia and use as donor a person of the same blood group as the recipient. We transfuse on an average of 600 c.c. of blood in these cases and believe that a relapse which does not show a tendency to spontaneous remission is an indication for transfusion. Some of our patients were transfused before splenectomy and others received transfusions afterward in the relapses which eventually occur in these cases. Dr. Minot has called attention to the increased activity of the bone marrow which follows splenectomy and is shown by the appearance of Howell-Jolly bodies, a rise in the leukocyte count and an increase in the blood platelets and reticulated reds. A similar change may be observed after transfusion and appears on the fourth to tenth day. This furnishes the most favorable time to do a splenectomy in these cases which have been transfused in preparation for the operation. The mortality of splenectomy in pernicious anemia should be very low, provided the right stage of the disease is taken to do the operation. I feel that it is a mistake to remove the spleen in a relapse. Such a case should be transfused and not operated on until it has reached the stage of improvement. There is a type of pernicious anemia, one whose course is steadily downward without remissions which does not improve with transfusion and, in our experience, this type of case shows very little change after splenectomy. As to results, the figures in our series of 15 cases agree with those given by Dr. Krumbhaar. The immediate effects of splenectomy are often strikingly favorable, but the longer the cases are followed the less encouraging they become.

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Splenectomy is capable of bringing about a satisfactory remission of considerable duration. It may last six months and rarely lasts a year. After this period the disease resumes its normal course. Removal of the spleen does not prevent the recurrence of relapses or alter their severity. I doubt whether it prolongs the patient's life unless the case is followed to the end and transfused in the relapses. Transfusion is undoubtedly the best treatment for a relapse. It does not give such a permanent result as splenectomy but makes the patient more comfortable and probably prolongs his life. Therefore splenectomy and transfusion are palliative, not curative. Splenectomy diminishes blood destruction and both splenectomy and transfusion are followed by bone marrow activity which brings about a temporary symptomatic improvement. This benefit is temporary and not always certain but nevertheless transfusion and splenectomy are the most effective means we have at the present time for the treatment of pernicious anemia.

Dr. Herbert Ziegler Giffin, Rochester, Minn.: This symposium is very important at this time because it crystallizes our ideas in regard to the present status of splenectomy for pernicious anemia. I can only add our own experience to that which has been given. It is almost exactly in line with the results that have been reported. Thirty-nine cases have been operated on with an operative mortality of 3 (7.7 per cent.). There is apparently no reason why the operative mortality for pernicious anemia should be high. There have been four postoperative deaths, leaving thirty-two living patients. Five patients are at present in relapses, so of thirty-nine cases there are twenty-seven patients in good or fairly good condition. One patient lived as long as three years. The longest period during which patients have maintained a good condition is one year, which occurred in two instances. Preoperative transfusions have been given preparatory to operation to improve the general condition of the patient, to initiate if possible an upward wave and to improve the characteristics of the blood count. One can predict that four patients out of five will show a very marked gain after splenectomy and it would seem that they should be given the opportunity to have this gain without very strenuous postoperative treatment. We have given postoperative transfusions only in relapses. I wish to speak here especially of the examination of the duodenal contents of pernicious anemia patients for the blood derived pigments. We have followed up the work of Schneider reported in January in the *Archives of Internal Medicine* in thirty-three cases of pernicious anemia and have obtained high values for urobilin and urobilinogen in the duodenal contents by the Wilbur and Addis spectroscopic test in all but three. In 12 cases examined a short time after splenectomy ten gave very

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low value. We have examined the duodenal contents for blood derived pigments in nineteen cases of a miscellaneous group with secondary anemia and have obtained low values. In four cases of hemolytic jaundice three have shown high values. This test may prove to be important in the study of patients with pernicious anemia. For instance, if a patient shows high hemolytic values in the duodenal contents and is able, in spite of active hemolysis, to maintain a good blood picture, he should be a favorable case for splenectomy: for splenectomy is followed by a reduction of the hemolytic values. With splenic anemia our experience is of thirty-three cases. The results are uniformly good. With hemolytic jaundice our experience is of ten cases with one death. In hemolytic jaundice there has been a very great improvement in the general condition of the patient, the jaundice and the anemia. We have one patient in excellent condition who was operated on eight years ago. One case of acquired hemolytic jaundice presented a pernicious anemia blood count. Cases of hemolytic jaundice in adults which show a pernicious anemia type of blood count are particularly interesting because of a possible close relationship between the two diseases.

Dr. W. S. Thayer, Baltimore: My first experience in which I had a splenectomy done in pernicious anemia dates from three years ago next November. That patient had already had distinct signs of spastic paraplegia. She made what appeared to be a complete recovery from the standpoint of her anemia and remained well for a year and a half. Her cord changes failed to progress. Then, in about two or three months, she rapidly went down hill with a relapse and died from a characteristic pernicious anemia. I felt that while we had only succeeded in producing a remission of the anemia that we had for the first time in my experience done something which arrested the progress of the cord changes and yet Dr. Krumbhaar is able to tell us that, as a rule, the cord changes have progressed without respect to the operation. Dr. Miller had an instance almost opposite to mine, that is, the anemia improved, but the cord changes grew rapidly worse. With splenectomy there is a temporary improvement in the majority of instances. The best figures show a considerable mortality from the operation. One is tempted to regard pernicious anemia as inevitably fatal and one is justified in seeking any remedy which may bring improvement. There are cases of long remissions — McPhedran's of sixteen years; others of shorter time. I myself saw one of five years and the patient died of another malady. We never need be utterly hopeless with regard to pernicious anemia and one must consider very carefully before advising splenectomy. We do in most cases accomplish a little something which we may not be able to accomplish under other circumstances, but it ought to be

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put very directly to the patient and it seems to me we should go very slowly in advising so serious a procedure. In regard to splenic anemia, particularly those with violent gastric hemorrhages, the results did not seem to be uniformly beneficial. My experience has been quite in accord with that of the other gentlemen who have spoken. In hemorrhagic jaundice the results appear to be almost uniformly beneficial, but there again one ought to consider very seriously the question of operation before advising definitely to have it done. If we are dealing with a case of congenital hemolytic jaundice, as a rule, the symptoms are not grave. I have three cases now under observation, in all of which the patient does not suffer much. There is a large spleen and a continued jaundice of greater or less degree quite endurable, so endurable that in none have I felt like advising splenectomy. One of these patients who underwent appendicitis associated with the removal of stone from the gallbladder withstood the operation as well as a healthy person and, indeed, three weeks after the operation the fragility of the blood was less than it was before. One should not urge an operation. The jaundice may be so serious and the anemia grave enough to justify it. In instances of acquired hemolytic jaundice it may be that the anemia is serious enough to make the operation almost imperative. These methods of transfusion have rendered the possibility of doing splenectomy in grave anemia a relatively simple matter where previously it would have been absolutely impossible. I remember an instance of splenic anemia, operated on by Dr. Finney, in a small boy, where he had waited six months that he might develop a good color. Finally, the boy's condition became so serious that he was transfused and taken to the operating room practically moribund and transfusion was done while operation was being carried out. By the end of the operation the arteries were spurting and the boy made a perfect recovery following the operation.

Dr. G. A. Friedman, New York: I shall limit my remarks to hemolytic jaundice. It is the third case of Dr. Peck to which I refer. The patient stated that he was sick for eight months and on close questioning, no other illness could be elicited, except that when he was very young he had a fever which lasted for several days. There was undoubtedly no hereditary tendency in this case. When first seen, I would say that he was more icteric than sick, and, practically, he came to the clinic, not so much for his symptoms, as for his jaundice. One of my co-workers on first examination suggested catarrhal jaundice. It is very important, and especially so in cases of young people, that the first thought that should come to the mind should be catarrhal jaundice. But an icterus which begins acutely with enlargement of the spleen should suggest hemolytic jaundice. We know well, however, that in a proportion of cases of catarrhal jaundice

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the spleen is enlarged and not the liver. But on considering more carefully the history in the case at hand, one must see that we are dealing with an entirely different condition. There was an absence of pruritus during the entire period of the illness — eight months. The absence of bile in the urine, and the presence of urobilin and urobilinogen, the presence of bilirubin in the blood, and the presence of bile in the stools, are aids in the diagnosis. The anemia here, however, was not marked. The resistance of the red blood cells to hypertonic salt solutions was only slightly diminished. It was between 0.35 to 0.45, but the percentage of the reticulated red cells was increased. The result of the operation was marked. Patient was practically free from jaundice on the fourth day after the splenectomy and on the eighth day there was no trace of it. I saw him at the end of last March. There was no jaundice and the patient was well. The medical treatment is absolutely without any benefit.

Dr. Samuel J. Meltzer, New York: I wish to point to a possible factor which, as far as I know, has not been referred to either in the experimental or in the clinical work on the subject. We know that the red corpuscles run in the middle of the blood stream and are, therefore, as a rule, not exposed to any kind of shocks. Some forty years ago I saw a fragile red corpuscle riding on the ridge formed by two dividing arteries. The blood cell was finally broken into two fragments. It then occurred to me that the blood corpuscles while passing through the spleen must be subject to innumerable shocks. The blood, after leaving the renal artery, passes through a considerable amount of alveolar tissue, before it enters into the renal veins. The blood cells in their rapid run through these tissues must continually come in conflict with some jarring ridges. This gave me the notion that fragile red blood corpuscles may readily break down in the spleen or may be prepared to give up some of the hemoglobin, and that some of the nucleated cells may lose their nucleus there. I was also thinking that the mechanical shocks which the white corpuscles receive while passing through the irregular arrangement of the alveolar tissue may be affected; it may possibly hasten their natural division. These considerations were the starting point for many of the investigations on the effect of shaking on red cells, bacteria, ferments and toxins. The first investigation of this kind was carried out in 1884, together with Dr. Welch. In the course of the last year Dr. F. L. Gates studied in our laboratory at the Rockefeller Institute the effect of shaking on red cells of splenectomized dogs. I am not ready to report here his results. I merely wish to call the attention of those who are interested in this subject that the mechanical effect of the alveolar construction of the spleen may have a certain influence on the red blood corpuscles, at least

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in pathologic conditions of the blood, and may be, therefore, a potent factor in certain forms of anemias.

Dr. Roger I. Lee, Cambridge, Mass.: The ordinary course of pernicious anemia is very bizarre, although it is next to impossible to tell from a few cases whether the effect of a particular therapeutic agent is favorable or not. The blood picture in pernicious anemia may be said to correspond roughly to blood destruction and blood formation. The same thing holds true of hemolytic jaundice and splenic anemia. We have studied splenectomy and transfusion from the point of view of the effect of stimulating the bone marrow activity by the method that Dr. Minot outlined. We have used no particular method, but we have used those general comprehensive estimates of all these methods. We do not think, for example, that the reticulate cells alone are of very great value, but the qualitative changes in the reticulate cells, especially with the blood platelets and white corpuscles, give us good information in regard to the bone marrow. After splenectomy and after transfusion we always get a slight tendency toward stimulation of the bone marrow. That stimulation of the bone marrow varies a great deal. It is much more constant. It is much more constant and energetic after splenectomy than after any other therapeutic procedure. The benefit of transfusion is to furnish bulk of blood which may then be destroyed very rapidly, but the main benefit of transfusion is to inaugurate a remission which means merely to stimulate the bone marrow and it is only by following the patients that we can tell whether they are benefited or not. We merely say that after splenectomy rather constantly and after transfusion occasionally one does see the signs of a stimulated bone marrow.

Dr. E. B. Krumbhaar, Philadelphia: It has been generally accepted not only that blood transfusions are a valuable prelude to splenectomy, but that in themselves they constitute an efficient method of combating pernicious anemia. In fact it remains to be proved whether or not equally good results would not be obtained by repeated transfusions in the absence of splenectomy, although the impression is prevalent that the improvement following splenectomy is more lasting. This is to be expected if it is borne in mind that whereas transfusion merely improves the condition of the blood, splenectomy removes the most apparent noxa. In connection with Dr. Thayer's remarks about the long periods of spontaneous remissions, I would call attention to Cabot's series of 1,200 cases in which only three patients were considered as "cured," in other words, did not develop symptoms during five years. May it not be that among the small number of splenectomized patients that we have thus far had opportunity to see, there is a group which will eventually give us a larger proportion of long surviving cases?

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I hesitate to use the word "cure," because we do not think of any of them as really cured. In regard to the use of the term "splenic anemia," I think most physicians would agree with Dr. Miller that it probably includes one or more clinical conditions of uncertain or varying etiology. But just as the hemolytic jaundices, and probably also von Taksch's disease have been separated from this group with profit, so also Gaucher's splenomegaly, with its unique pathology and well-defined symptom complex, should to my mind be considered an independent condition. Thus "splenic anemia" in the present state of our knowledge might profitably and feasibly either be discarded entirely, or considered as synonymous with Banti's disease, or with the two early stages of that disease.

Dr. Joseph L. Miller, Chicago: Not every patient with hemolytic icterus is inconvenienced by it. In fact, the majority of these patients suffer little or no inconvenience aside from discoloration of the skin. For this reason, Türck has referred to it as a cosmetic disturbance rather than a disease. It would seem, therefore, a question whether an operation with a mortality of at least 10 per cent. should be undertaken in these cases of hemolytic icterus, unless the person shows a definite disturbance or unless he should be willing to undertake the risk associated with the operation in order to be relieved of the icterus. There has recently been a report of three cases of hemolytic icterus cured, the result of Roentgen-ray treatment. In those cases in which splenectomy is not undertaken it might be well to try the effect of the Roentgen ray to see whether a cure might be effected.

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REMOVAL OF THE RIGHT COLON: INDICATIONS FOR TECHNIC

CHARLES H. MAYO, M.D.
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For many years the indications for the surgical treatment of megacolon, tumors, fistulas and some diseases of the colon have been definite. The principles involved and the technic employed have been carefully considered along lines of theoretical, experimental and practical development. The results of cure or relief within the natural limitations of the character and the extent of the diseases have been excellent. Within a few years still greater progress has been made in our knowledge of diseases of the colon, largely because of the endeavor to treat surgically not only stasis as an entity, but also various acute and chronic diseases, general and local, resulting from it, or, when other cause is not apparent, presumed to result from it. Thus, in chronic changes in the circulation, such as endarteritis, in the nervous system, such as in epilepsy and neurasthenia, in muscle degeneration, rheumatoid arthritis, enteroptosis and various chronic so-called toxic diseases, surgical treatment by removal or short-circuiting the bowel was along lines already developed for the removal of tumors or the treatment of obstruction.

These theories have been developed mainly by the work of Lane,[1] who in short-circuiting and removing the colon made practical application of the view of Metchnikoff, namely, that the bacterial flora of the colon is responsible for many of the chronic ills of

1. Lane, W. A.: Chronic Intestinal Stasis, Brit. Med. Jour., 1912, i, 989; Surg., Gynec. and Obst., 1910, xi, 495; Lancet, London, 1912, ii, 1706.

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man, and that if it were possible to eliminate or shorten the colon, these ills would be decreased. There is just enough truth in this theory and sufficient that it is not true to require years to standardize the diseases and conditions between the border lines of medicine and surgery, in which the elimination of the colon will give sufficient improvement over the results of therapeusis to justify such surgical intervention. This period will be reached only when the collective judgment of the profession can select the proper cases. While Lane may be overenthusiastic in his claims, he deserves credit for much of the knowledge of the physiology and disease of the colon possessed by the medical profession today. There is no controversy concerning operations for tumors and for obstructions.

In properly selected cases of constipation, great benefit can often be obtained by the surgical elimination of the absorbing area of the colon. It is certainly not advisable for simple constipation, but is advisable for some selected severe cases in which the patients are disabled by the condition in spite of prolonged and varied treatment. At the present time the patients considered suitable subjects for this procedure are those who are toxic from the condition, the drugs or the absorption of unpassed intestinal contents after taking physic, and in whom the Roentgen ray shows a stasis of from three to four days' duration, which is often associated with complicating chronic infections.

We have performed general colectomy in a few cases, and the right or partial colectomy in a larger number, and we believe that except in cases in which there are tumors and local disease, the latter operation is as good for the relief of symptoms as the general colectomy. First, it removes the greatest absorbent surface in the colon; second, it is not so severe an operation, and third, it preserves the omentum, the loss of which is a serious consideration in itself, reducing protection, warmth, mobility, and the equalization of the abdominal circulation. The general colectomy

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often apparently leads to matting adhesions of the anterior layers of the intestine. In some cases, as reported by Clark,[2] these adhesions cause serious disability and in many cases require further operation and occasionally result in death.

It is true that much of the present-day surgery has been taken from fields formerly classified from the therapeutic standpoint as medical, and in the slow process of change the surgeon has been held in check by a constant dispute of the ground. Specialists have been developed who treat the stomach, the first portion of the intestine and the upper abdomen, and others who devote their attention to the lower end of the colon and pelvis. Thus it is that several yards of bowel have been left as an unclaimed field—not only unclaimed, but not wanted—and this has been forced on the surgeon for the relief of numerous chronic ailments, many of which are incurable.

In judging the probable or possible benefits of the surgery of necessity or expediency, the development and function of the large bowel should be taken into consideration.

Like the stomach and urinary bladder, the colon has a shorter heredity than the small intestine. Originally it was equipped on its right side with absorbing villi like those of the small intestine, which disappeared early. The first portion of the colon is an absorber of fluids which are taken through the portal circulation, while the left half of the colon, especially its lower portion, has become, through convenience, an organ for the storage of the drier fecal matter. It is the natural habitat of several microbes, the activities of which produce a considerable part of its fecal contents. Such bacteria are harbored throughout life; consequently, a considerable degree of immunity to them is natural to the individual even when they become misplaced.

2. Clark, J. G.: The Removal of the Colon for Obstructive Fecal Stasis, with a Report of Eight Cases, Tr. South. Surg. and Gynec. Assn., 1913, xxvi, 358.

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Several diseases chronic in character, local and general, are caused by varieties of intestinal bacteria and protozoa which are not sufficiently common for the development of immunity.

The lymphatics of the colon are limited in comparison with those of the small intestine, which are very numerous. Reasoning from the nature of the contents of the colon, the converse would appear to be true; but as I have pointed out,[3] it is probable that the lymphatic supply was limited so that the septic colonic contents might be passed through the liver. This provision of nature explains why malignant diseases of the colon remain localized for such long periods as compared with malignant diseases of the small intestine. Butlin [4] shows that in about 50 per cent. of patients with malignancy of the colon, the disease at death is still local. In young persons, however, the lymphatics are more active, and earlier distribution of the disease is evident. This is true also of cancers located in the transverse colon with its associated omental glands.

The entrance of the small bowel into the colon is closed by the ileocecal valve, which is rather badly constructed mechanically and often ineffective. By one series of observers, it is looked on as acting to delay the passage of the contents of the ileum until further time is given for absorption of nutriment. Simple constipation has been relieved by enlarging the ileocecal valve (W. J. Mayo).[5] Others believe the valve acts to prevent the entrance of gas and bacterial products from the colon to the ileum, whose absorbing villi do not have the liver for a purifying agent, and some surgeons operate to reconstruct the valve (Kellogg).[6] Symington's[7] description of the valve

3. Mayo, C. H.: Surgical Physiology of the Lymphatic System, Tr. South. Surg. and Gynec. Assn., 1903, xvi, 442.
4. Butlin, H. T.: On the Operative Surgery of Malignant Disease, Philadelphia, P. Blakiston's Son & Co., 1900, p. 260.
5. Mayo, W. J.: Ileocecal Orifice and Its Bearing on Chronic Constipation, Ann. Surg., 1900, xxxii, 364.
6. Kellogg, J. H.: Incompetency of the Ileocecal Valve the Most Common Cause of Ileal Stasis, Lancet-Clinic, 1915, cxiii, 602.
7. Symington, cited in Cunningham, D. J.: Text-Book of Anatomy, New York, William Wood & Co., 1907, p. 1078.

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shows that its inefficiency is due largely to the obliquity of its entrance into the cecum; also to its lower attachment to the inner cecal wall and partial invagination into the cavity of the large bowel. In this respect it forms a mechanical barrier against back-flow such as is formed by the mechanism of the common-duct entrance into the duodenum and the entrance of the ureter into the bladder. The viscus under tension compresses the duct entrance and requires at all times some muscular effort at delivery of its contents. Peristalsis of the intestine is stimulated by the intestinal content and varies with its variety or irritating qualities. In the small intestine it is fairly regular and constant until the bowel is emptied. This propelling effort is accomplished by the action of the circular and longitudinal intestinal muscles. The peristalsis of the colon differs from the peristalsis of the small intestine in that it is not constant; the fluid contents of the ileum passing into the cecum remain at rest for a considerable period of time until consistency is increased by the absorption of fluid. Metchnikoff is undoubtedly right in his claim that in health a great portion of the body fluids are absorbed from the large bowel. The cecum normally empties but a few times in twenty-four hours. In the large bowel these movements are usually accompanied by an audible gurgling. In the right colon a slight reverse peristalsis has been demonstrated which favors delay. Delay in the right colon is due to the attachment at the splenic flexure, which forms a simple kink-valve or bend in the tube. This must be of importance as it is the most constant attachment of the colon. Rising nearly as high as the entrance to the stomach, it prevents siphonage. The fact that the intestine is a muscular tube within a muscle-walled cavity makes all operations which depend for drainage on gravity ineffectual in the majority of instances. Peristalsis of the colon is also stimulated by the intestinal contents, the movement of which is caused by contraction of the

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circular fibers for steadying and pushing, and aided by the sacculations. The latter are formed by the three muscular ribbons, which are one-sixth shorter than the total length of the large bowel. In the forward movement of the thicker intestinal contents, the muscular ribbons serve as tractors. Space is made for the advance by the distention of the intestinal walls by the gas normally present. Thus a cecal sigmoidostomy will drain if the obstruction is above the cecum. Without obstruction, it may make a vicious circle. For various reasons the operation has been unpopular. A few patients, however, have been reported as benefited by it.

It has been shown that there is a wide variation in the length and size of the intestine in different persons; the shortest intestine on record was 8 feet long, and the longest, 33 feet (Lynch and Draper [8]). We thus have the extreme carnivorous type and the herbivorous type. While all of the colon can be sacrificed with the maintenance of approximate good health, the loss of more than one half of the small intestine is most serious.

The large bowel originates on the left side of the abdomen, the cecum rotating around the abdomen from left to right. At about the third month it is beneath the stomach and later rests beneath the liver and over the right kidney, until shortly before birth, when it descends to its final position in the right iliac fossa. Occasionally, according to Treves,[9] this descent may be delayed up to two years after birth, and rarely the rotation may not occur or the cecum may be permanently fixed over the right kidney. According to the period of descent it may ride over the top of the parietal peritoneum, developing a long mesentery, the "cecum mobile" of Wilms, or it may burrow through it, covering itself with an extra layer of peritoneum. Between these two extremes and the normal are the

8. Lynch, J. M., and Draper, J. W.: Anastalsis and the Surgical Therapy of the Colon, Am. Jour. Med. Sc., 1914, cxlviii, 828.
9. Treves, F.: The Anatomy of the Intestinal Canal and Peritoneum, Hunterian Lectures, Brit. Med. Jour., 1885, i, 415, 470, 527, 580.

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various forms of veils, adhesions and fixations as supporting ligaments described by Long,[10] Jackson,[11] Pilcher,[12] Gerster,[13] Gray,[14] Pringle,[15] Binnie,[16] Eastman,[17] Flint[18] and Lane. It is at once evident that, because of the rotation, all vessels and nerves of any importance are to be found on the inner leaf of the mesentery, the outer fold being principally fixative. Division of the latter adds greatly to the mobility of the bowel without impairing its vitality and simplifies some operations on it.

In the development of the intestine the vitelline duct (or should a remnant be left, a Meckel diverticulum) is attached to the ileum about 2¾ feet from the ileocecal valve (Cunningham). Embryologically, then, the lower ileum is developed with the colon.

It is to be noted that in those operations in which the colon is removed—for example, Lane's operation—or in which in certain diseases it is rendered completely functionless for considerable periods by means of a low ileostomy as advocated by Brown,[19] the lower ileum becomes dilated and takes the place of the colon. Clark shows the dilatation of the ileum to be regular following colectomy. In low ileostomy the fluid contents of the ileum soon thicken, and emptying occurs at intervals with less gas and little odor.

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10. Long, J. W.: Pseudoperitoneal Cauls of the Colon, South. Surg. and Gynec. Assn., 1912, xxv, 446.
11. Jackson, J. N.: Membranous Pericolitis, Tr. West. Surg. and Gynec. Assn., 1908, xviii, 269.
12. Pilcher, L. S.: Surgical Aspects of Membranous Pericolitis, Ann. Surg., 1912, lv, 1.
13. Gerster, A. G.: On Chronic Colitis and Pericolitis, Ann. Surg., 1911, liv, 325.
14. Gray, H. M. W.: Chronic Intestinal Stasis, Brit. Med. Jour., 1914, i, 188.
15. Pringle, S. S.: Chronic Intestinal Stasis, Brit. Med. Jour., 1914, i, 183.
16. Binnie, J. F.: Pericolitis Dextra, Month. Cycl. Prac. Med., 1905, xviii, 341.
17. Eastman, J. R.: The Foetal Peritoneal Folds of Jonnesco, Treves and Reid and Their Probable Relationship to Jackson's Membrane and Lane's Kink, Surg., Gynec. and Obst., 1913, xvi, 341; A Further Study of Pericolonic Membranes, ibid., 1914, xviii, 228.
18. Flint, J. M.: Embryonic Bands and Membranes About the Caecum, Johns Hopkins Hosp. Bull., 1912, xxiii, 302.
19. Brown, J. Y.: The Value of Complete Physiological Rest of the Large Bowel in the Treatment of Certain Ulcerative and Obstructive Lesions of this Organ, with Description of Operative Technique and Report of Cases, Tr. South. Surg. and Gynec. Soc., 1912, xxv, 440.

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TECHNIC

In operating on the right colon an incision is made in line with and through the right rectus. It should be ample in length to give free working space. Following a cursory examination of the right colon, a general exploration of the entire abdomen should be made to search for metastases in malignancy and also to avoid overlooking associated disease, thus preventing useless or unnecessarily extensive operations in malignancy or failing to make them sufficiently extensive.

If extirpation is decided on, extensive protective gauze packing is adjusted to the inner side of the colon. An incision is made along the white fold of parietal peritoneum where it joins the peritoneal covering of the outer side of the colon. This permits of extreme mobility and allows the bowel to be elevated outside of the abdominal incision. The space to the outer side is filled with a protective gauze pack. The ileac mesentery is perforated, and the ileum is divided between double clamps 3 inches from the ileocecal valve, the cut ends projecting from the forceps being sterilized with the actual cautery. From below up, the mesentery of the cecum and ascending colon is divided between forceps up to the transverse colon, and the omentum is ligated and separated from the right one third of the transverse colon (Fig. 1). At this point the colon is divided between clamps, the loose bowel removed, the projecting stump from the distal clamp also being treated by cautery. The vessels supplying this region, few in number and readily seen, are ligated with catgut. In nonmalignant cases the division of the mesentery is made closer to the bowel, while in malignancy more of the mesentery is taken, including the lymph glands which drain the area. Care should be taken in the separation of the colon to avoid injury to the duodenum. While the ureter should be observed on the right side, it does not come into the operative field except in extensive malignancy when ligation of the

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ureter or removal of the kidney may be necessary. We have been able to remove such advanced tumor growths in numerous instances, including several in which the patients had been explored and declared inoperable from one to several months previously. In the latter type of cases the tumors are usually adherent to the incision in the abdominal wall and require a block removal of the entire area over the growth. In such cases there is greater danger of recurrence in the abdominal muscles than of recurrence within the abdomen.

Using chromic catgut as a suture, the end of the colon is prepared for closing by inserting the needle and catching into the bowel first on one side and then the other over the forceps, including the peritoneum and muscle, the loops crossing the forceps being left loose. Any contents of the bowel are now forced onward, and a rubber-covered clamp applied for control about 4 inches from the end. The forceps closing the end of the bowel are now removed, the end opened and the female or spring side of a proper-size Murphy button pushed through the loose sutures into the opening and left loose within the colon (Fig. 2). The two ends of the thread being drawn taut, immediately invert the mucous end of the colon and approximate the peritoneal surfaces. A second row of sutures is applied to make the closure more perfect, the ends of the suture being left long. (Ligation of bowel end and purse-string invagination is equally good.) The button within the bowel is manipulated so that its tube is pressed against one of the muscular bands, about 2½ inches from the end of the bowel. The bowel is incised on the tube of the button, so that it can be pushed through the wall of the intestine, no suture being used. This is held until the other half of the button is adjusted into the end of the ileum by suture. The two halves are then pushed together, making an end-to-side union. If deemed necessary, a few interrupted sutures of fine catgut or silk may be used over the button, to

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adjust adjacent epiploic tags or omentum for protection and support at the point of union. The anastomosis can be made by suture, but the Murphy button is safer, quickly adjusted and ideal for the purpose. Some prefer side-to-side union in spite of the tendency to dilation of the blind ends. The triangular opening in the mesentery beneath the union is now closed by catgut suture. A few sutures are inserted to adjust the parietal peritoneum over the exposed cellular tissue from which the colon was separated (Fig. 3). The wound is now closed, the end of the colon being drawn into the peritoneal opening as closure is made. The colon is brought into the muscle but not through it, the muscles being sutured above and below this point; the long suture from the end of the bowel hangs out of the incision. A strip of gauze is inserted to the end of the bowel to keep the muscles apart. The procedure is employed as a safety valve to relieve gas should stasis with great distention occur between the fourth and sixth days. Peritonitis causes most of the deaths by necrosis of the union from distention. In a series of twenty cases we have had no deaths from the use of the Murphy button and the safety-valve method. By drawing on the projecting suture and using small pointed forceps along the taut thread, the bowel is readily opened and gases permitted to escape. If not required by the sixth day, the suture is cut, the gauze removed and the opening allowed to close. If the suture is not needed, the healing is not prolonged; if needed, closure is usually effected within a short time (Fig. 4). This safety valve is of great benefit in about 15 per cent. of the cases. Should the peritoneal cavity be contaminated, drainage is secured by stab incision with drain in the loin.

The method of operation described is safe and remarkably effective for tumors, granulomas and fistulas. In cases of toxemia the general condition is improved, and in 80 per cent. the constipation is

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improved. The general improvement made in the latter cases is somewhat less marked than in operations of necessity for tumor and obstruction (Fig. 5). In operating on the left colon for obstructive conditions by the Mikulicz-Bruns method or by resection, appendicostomy is of great value.

Not including the rectum, there were 262 resections of the large intestine for malignancy. Of the patients who recovered and who were operated on more than five years ago, 54 per cent. are alive. Of those operated on more than three years ago, 67.5 per cent. are alive.

From January, 1898, to Dec. 31, 1915, the right half of the colon was resected for tumors, disease and stasis in 235 cases, with an operative mortality of 12.5 per cent. In our early work the operability was lower, the mortality lower and the permanency of cure higher. This led to an increase in the operability of these otherwise hopeless cases, with the result that there was an increase in the mortality and a decrease in the permanency of cure; but considered from the standpoint of the total number of cases seen, a great increase in the number cured. The present operability is 62 per cent. Unless the operability percentage is given, statistics in regard to the results of operations for malignancy are misleading.

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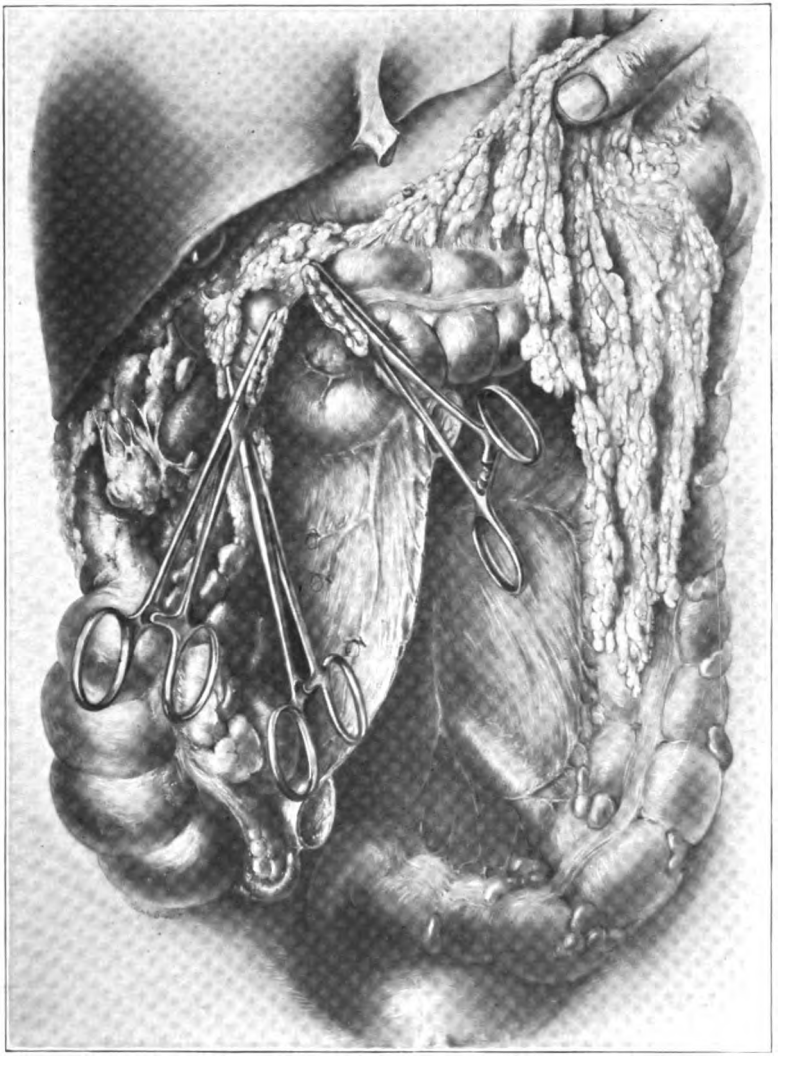

Fig. 1.—Removal of right colon, showing lines of section.

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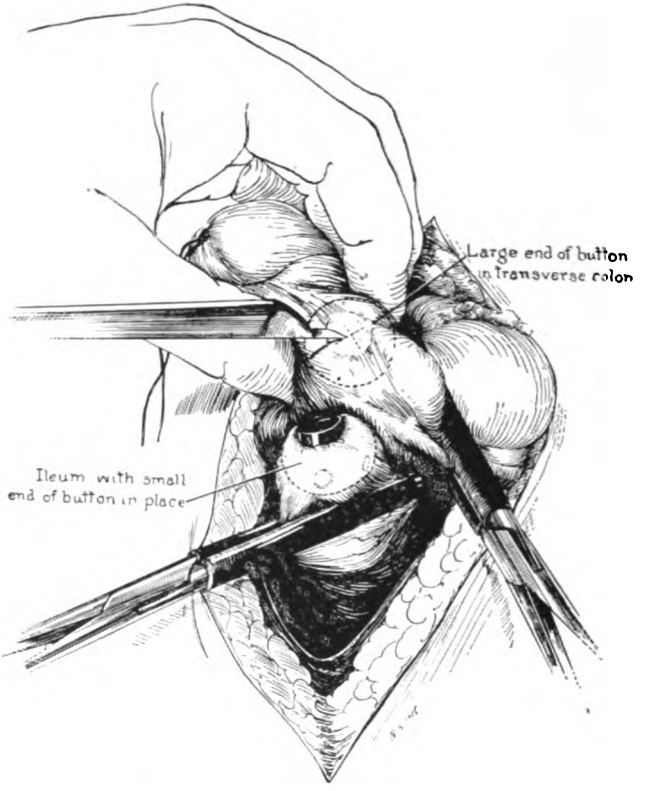

Fig. 2.—End-to-side union by Murphy button.

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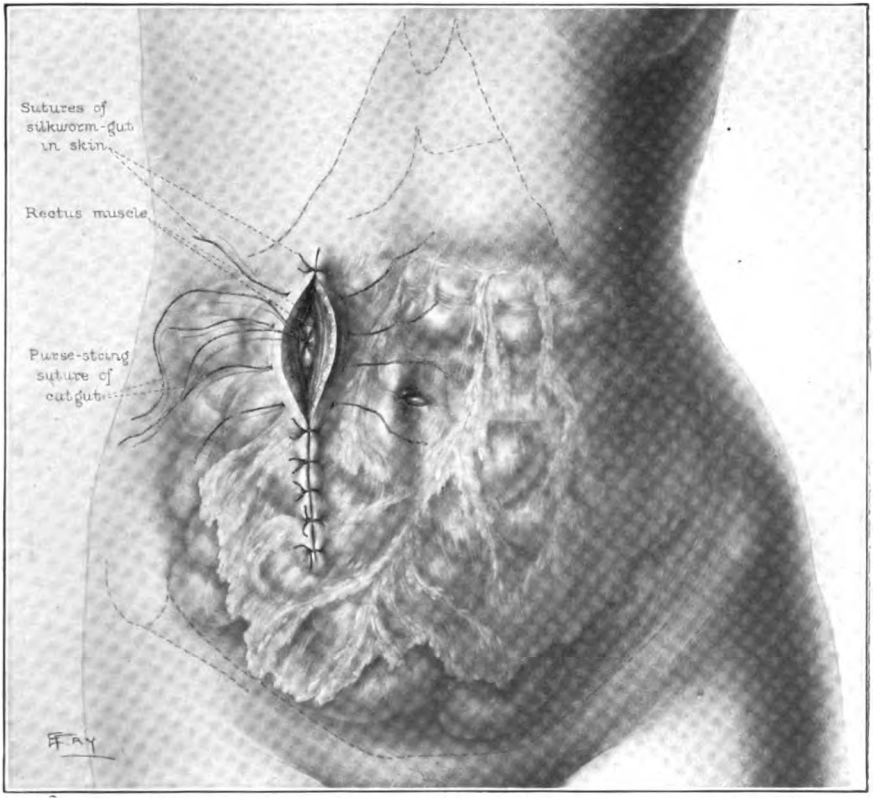

Fig. 3.—Incision, showing method of closure and end of bowel indepth of wound.

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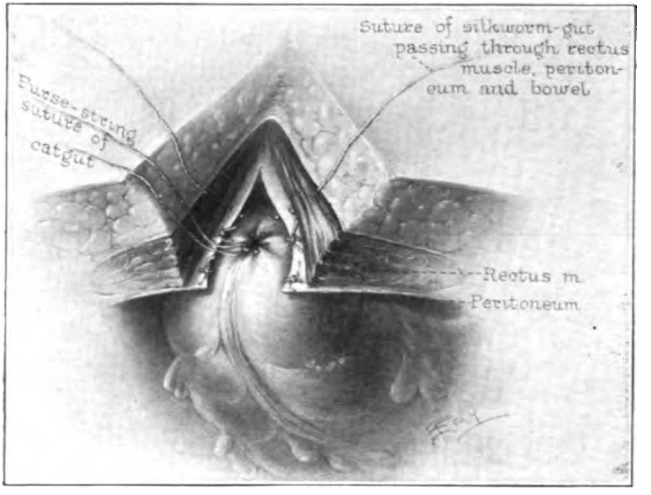

Fig. 4.—End of colon brought up to peritoneum and sutured.

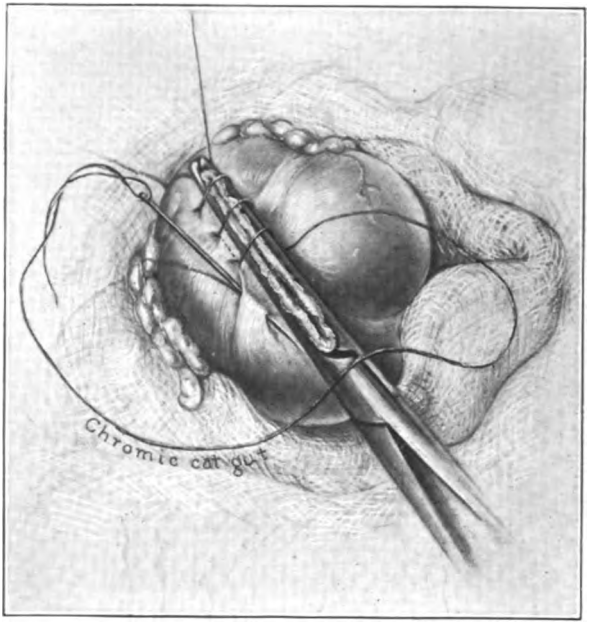

Fig. 5.—Aseptic method of inverting mucous membrane by a running suture.

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THE VALUE OF ILEOSIGMOIDOSTOMY AND SIMILAR PROCEDURES

IN THE TREATMENT OF CHRONIC MULTIPLE ARTHRITIS

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Whether or not its truth is admitted, the originality of Lane's idea and the brilliancy with which he translated the thought into action must be admired. Chronic infectious arthritis had long been a troublesome thorn in the side of the profession; in an occasional case there was spontaneous recovery or amelioration of symptoms following this or that mode of treatment, but it was generally recognized as a fact that in the average case of chronic infectious arthritis medical science offered little hope of cure. The many theories as to the etiology of the disease and the numerous methods advocated for treating it bore strong witness to our lack of definite knowledge as to its real cause, and, despite treatment, the sufferers usually continued to suffer and, through alternating periods of relative quiet and of acute torture, passed slowly on into years of utter helplessness. What wonder, then, that the attractive theory of intestinal stasis with its resulting sequelae of microbic invasion, toxemia and joint infection and its possible relief by a relatively safe and simple surgical operation should draw wide notice and that both surgeon and patient should hasten to test in the fire of experience the practical worth of the novel thought! For it is only through actual experience on human beings that the degree of worth in such an idea can be truly estimated, since under no other circumstances can the real conditions of the disease be reproduced. It is only because of this fact and

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because the present number of reported observations is relatively small that Dr. MacAusland and I presume to present to this section the result of our work in such a limited number of cases. Our paper makes no pretense of being anything but a record of the effect, immediate and remote, of ileosigmoidostomy, etc., in cases of chronic, multiple nontuberculous arthritis.

Other series have been published, the most significant, perhaps, being one by Fagge and Hughes[1] and another more recently by Rea Smith[2] in a paper presented before this section last year.

The first-mentioned authors draw their material from the records (from 1909 to August, 1914) of Sir Arbuthnot Lane and give the results obtained through the performance of colectomy (four cases) and ileosigmoidostomy (three cases) in persons with multiple, nontuberculous arthritis. The immediate results were good in all instances; the pain and the joint stiffness were less, and the patients all felt more comfortable. The late results were in the main fairly satisfactory. Two cases could not be traced; in one, in which a colectomy was performed, the patient died of pulmonary embolism on the thirteenth day; of the other four, two may be classed as recoveries (one and one-quarter and two and one-half years after operation) to all intents and purposes, one as continuing to improve at the end of three months and the fourth as unchanged, two and one-half years after operation.

Of course, recovery, when spoken of here in connection with joints, is not to be understood in the sense that bony ankylosis and gross deformities disappeared. It means that such initial conditions as swelling, effusion, tenderness, etc., and their immediate sequelae were remedied.

I have been unable to find a detailed account of Smith's cases, but his results are remarkably good. He reports the outcome of his experience with four-

1. Fagge and Hughes: Brit. Jour. Surg., 1914-1915, ii, 657.
2. Smith, Rea: Ileocolostomy and Colectomy for Arthritis Deformans, The Journal A. M. A., Aug. 28, 1915, p. 771.

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teen patients. In two instances he did a primary colectomy, and this procedure was followed by a marked benefit to both patients. In twelve of the cases, ileosigmoidostomy alone was done as a primary measure. One of the patients died on the fifth day in uremic convulsions, a death which may not be laid at the door of surgery, as Smith notes; five were very greatly improved, three to the stage of resuming their usual work; in the remaining six patients, while temporary improvement followed the operation, it was not permanent and they soon relapsed into their former conditions; four of the six underwent a second operation, colectomy, with great and seemingly permanent benefit to three of them. How long after operation the report was made, I do not know. Thus, ten of the fourteen patients on whom Smith operated were either cured or put in such condition that they could get about without assistance, a truly remarkable showing.

Our series consists of ten cases; in eight, ileosigmoidostomy was done. In all these the ileum was cut across about an inch and a half above the ileocecal valve, and the end of the distal portion was inverted and closed; in four instances, the end of the proximal portion was also closed and a lateral anastomosis with the lower sigmoid carried out; in the other four, the open end of the proximal arm was implanted into the side of the sigmoid. In one of the remaining cases cecosigmoidostomy was done; in the other, a hemicolectomy, the proximal end of the ileum being implanted into the side of the distal portion of the transverse colon. There was no mortality. In one case, the only one in which a cure really followed, a technical defect gave rise to a fecal leakage which was successfully repaired at a second operation.

The immediate effect of operation in these cases is always a beneficial one, remarkably so in some instances. This fact has been noted by others. In one case of Lane's series, the day following operation saw a striking change in the patient's condition;

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there was an increase of 25 degrees in the extension of the knee-joints and, for the first time in six months, the patient could hold a pen in her right hand and could write her name. While I have observed no such wonderful alteration as this in the joint conditions, it cannot be denied that in many ways the patients receive marked and speedy relief from the operation. The cold, moist hands and feet become warm and dry; the tender, painful joints feel easy and comfortable; the clammy sweats cease, and the patient experiences and admits a general betterment. In other words, the purely toxemic symptoms are relieved and the relief comes quickly, in from forty-eight to seventy-two hours, as a rule. Later, in favorably influenced cases, there follow subsidence of the swellings about the joints, especially the small ones, an increase in the degree of joint motion and a change for the better in the regularity and character of the bowel movements. Even in cases that later relapse, the amelioration may continue for some time, weeks, months or even a year (as happened in one case of our series) and thus give promise of permanency. Usually, however, in our experience the gain has been general rather than local, temporary rather than permanent. The general bodily health improves and continues to be better permanently, while the joint conditions, though they may be relieved for a longer or shorter time, usually relapse ultimately into their former or even a worse state.

In our series of ten cases we can boast of but one cure. After ten years of more or less constant trouble with hands, hips, knees, ankles and feet, a young man willingly submitted to ileosigmoidostomy, and now, almost three years after operation, remains entirely well. I wish I knew exactly why. A second patient, ten months after a hemicolectomy, reports herself as continuously improving both in her general and in her arthritic condition. She is one of the two patients who complain of postoperative diarrhea; she has six

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or seven bowel movements daily; in the other patient, diarrhea is only occasional. A third patient gained much for a year and then fell back into her former wretched state. To the other seven, operation gave no relief as far as their joints were concerned, but it improved their general health; four state that their joint condition is worse. These reports indicate the condition of our patients from one and one-half to three years after operation.

SUMMARY OF RESULTS IN THIRTY-ONE OPERATIVE CASES

Results	Colectomy	Ileosigmoidostomy	Total
Cured or greatly improved	5 (2 primary, 3 secondary)	7	12
Considerably improved	3	1	4
Worse	..	4	4
No change	1	6; 4 other cases (a total of 10) were not influenced by ileosigmoidostomy and had a subsequent colectomy	7
Death	1 (pulmonary embolus)	1 (uremia)	2
No report	2	..	2
Total	12	19	31

In these three series, then, we have to do with thirty-one cases of multiple infectious arthritis. Two of the patients could not be traced, and hence the late result in these cases is not known. Of the twenty-nine others, twelve were cured or greatly benefited, five by colectomy (primary or secondary) and seven by simple ileosigmoidostomy. Considerable improvement followed colectomy in three cases, and ileosigmoidostomy in one. Colectomy left the condition unchanged in one case, and ileosigmoidostomy in six; four of these patients later submitted to secondary colectomy with permanent (as far as we may judge) relief to three of them. Four patients were worse after ileosigmoidostomy than before it. One death (pulmonary embolus) followed colectomy, and one (uremia), ileosigmoidostomy.

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In estimating the value of any mode of surgical treatment, proper regard must be had for both the mortality and the morbidity that is connected with its accomplishment. Sir Arbuthnot Lane[3] believes that the immediate risk of ileocolostomy is greater than that of colectomy, and that the convalescence after the latter is far less bothersome. This statement may represent the truth in Lane's clinic, but I am sure it would not hold true for the average surgical clinic in this country: for Lane has brought his own technic to a very high level in the performance of colectomy, and has had wider experience with that operation than any of us will probably ever have. It seems certain, however, that the mortality from neither procedure is prohibitive. The death from uremia in one of Smith's patients was not unexpected; the surgeon had recognized the condition before operating, and the patient had full appreciation of the chances and was willing to take the risk; the fault, if fault there was, is neither surgery's nor the surgeon's. The patient to whom pulmonary embolism brought death ran the same risk as the healthiest of us would have to take, if he submitted to a laparotomy for any cause whatever. If we may draw conclusions, then, from a study of so limited a number of cases, it is a safe assumption that the mortality rate need not cause undue apprehension. Nor can any increase in morbidity be said to follow these procedures. In only two cases did diarrhea result, and diarrhea is the only postoperative sequela we encountered; in one it was almost negligible, being only an occasional event, while, in the other, it was troublesome. In the balance against this must be weighed the fact that amelioration in general health was attained in all the patients, that a better working condition of the bowels was secured and maintained, and that even those whose joint conditions grew worse were suffering from the effects of the uninfluenced disease and not of the operative procedure.

3. Lane, Sir Arbuthnot: Brit. Jour. Surg., 1914-1915, ii, 599.

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When and on what grounds, then, shall abdominal section be urged in these cases? Of course, the earlier the patients reach the surgeon the better is the chance of cure. When advanced destructive joint changes have taken place, no treatment can bring about complete relief. It is unfortunate but true that many sufferers from chronic arthritis pay little attention to the often slight primary signs of the disease, the discomfort and the stiffness frequently confined for a time to the finger joints, the wrist, etc. It is only when the trouble has spread to other and larger joints that the patient takes alarm and seeks a physician, who himself often fails to appreciate the possibility that some focus of infection, more or less obscure, may be the active cause of the trouble and by his hit-or-miss method of treatment postpones still further the introduction of at least intelligent attempts at relief. It should be emphasized that, just as soon as there arises even a suspicion that the process may have an infectious cause, painstaking search should be made for that cause. The mouth, gums, teeth, tonsils, throat, nose and accessory cavities should be carefully investigated. Roentgenograms of the skull, with special reference to diseased sinuses and to the possibility of slumbering, unsuspected infections about the dental roots, should be made. Urethral, vaginal and uterine discharges should be stained and examined microscopically. The urine should be carefully searched for evidence of renal infection. Hugh Young warns us, too, that the seminal vesicles may harbor the guilty organism. When all other possible sources of infection have been excluded, either through demonstration of their absence or through their elimination by suitable treatment, then attention should be turned to the intestinal tract and to the possibility of intestinal stasis, the frequent predisposing cause, if current opinion is correct, of the formation and absorption of intestinal toxins and perhaps even of microbic invasion of the blood current. Smith believes that the intestine may be the

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real primary source of many of the foci of infection which themselves are now regarded as truly primary. The cure of some cases of general infection without recourse to treatment directed to the intestinal tract is not confirmatory of the universal truth of this opinion.

The discussion of just what intestinal stasis is, of its cause and of just how much dependable knowledge of either or both may be obtained from the average roentgenographic examination is most interesting. It must be admitted that there is lack of agreement on many phases of this topic. Mr. Arthur Keith[4] of London, for instance, studied roentgenograms by Jordan of many cases of intestinal stasis (a term, by the way, which he considered "somewhat elastic"), and never succeeded in finding one which gave him satisfactory evidence of pressure or traction of a peritoneal band on the intestinal tract. His anatomic investigations on colons removed by Lane simply strengthened him in this opinion. In fact, he believes that neither position of the intestine nor peritoneal bands play an important rôle in the causation of chronic intestinal stasis, which, in his mind, is always secondary to a disorder of the neuromuscular mechanism of the bowel. All this is quite contrary to the impression that may be taken from the writings of other men. Again, Rinkenberger[5] of Los Angeles, working in Lane's clinic in 1911, demonstrated in healthy young men roentgenograms absolutely identical with those which Lane was showing as indicating intestinal stasis. My own experience with roentgenologists in this field has led me not to accept their interpretations as absolutely definitive. With our patients, the assumption of the presence of intestinal stasis and the consequent recommendation of operation has been reached more through a process of exclusion than through a certain demonstration of the stasis by roentgenograms. A

4. Keith, Arthur: Brit. Jour. Surg., 1914-1915, ii, 576.
5. Rinkenberger, F. W.: Abstr., The Journal A. M. A., Aug. 28, 1915, p. 770.

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careful search was always made for sources of infection other than intestinal. These being absent or eliminated, the presence of intestinal stasis and toxemia was assumed. The roentgenologic examination was regarded simply as or as not corroborative. It may be said in passing that in all our cases the roentgenologist reported "ileac stasis." In none of the cases, however, was an evident anatomic cause for the stasis demonstrated at operation.

I must admit that my mind is not entirely clear either as to why operation benefits some cases and does not influence others, or as to just what it is that operation does in some cases and fails to do in others, with or without relief to the patient. The doing away with the so-called ileal stasis by drainage of the terminal ileum is not the curative, or, perhaps, I should say not the only curative, factor in a successful operation; for, in the sole case in which we can honestly claim a real cure, a roentgenogram taken a month ago (three years after the operation) shows a markedly dilated ileum and all roentgenographic signs of ileac stasis, twenty-four hours after the injection of the bismuth meal (4 ounces of bismuth in a pint of buttermilk). Yet the man's general health and joint conditions are entirely normal. It may be that Smith's idea is the correct one and that the factor essential for success is either removal of the colon or, if the colon is left in place, absence of any obstruction in the colon between the cecum and the point of anastomosis; in other words, if the colon is sidetracked, the segment thus excluded must be freely open, entirely unimpeded and fully capable of emptying itself. Supportive of the correctness of this idea is the fact that in seventy-two hours the colon in our cured patient was practically entirely free of all the bismuth introduced through a bismuth enema. Only a very small remnant remained in the ascending colon, and for some reason that small remnant was still there thirty days after the giving of the enema.

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With relatively so little clinical material on which I may base a judgment, I do not feel justified in drawing conclusions of a definite character as to the general efficacy of either colectomy or ileosigmoidostomy in these cases. My present feeling in the matter may be set forth about as follows:

1. In many instances heretofore we have been dealing with long-continued, advanced cases in which neither operative nor any other method of treatment may be justly expected to be of much avail; hence, cases in which the probability of an intestinal source for the infection can be established should have an early operation.

2. Before advising abdominal operation in any case, all foci of infection other than intestinal should be sought for and, if present, should be eliminated.

3. Every patient to whom operation is proposed should have set before him clearly the pros and cons of operation, its possibilities and its uncertainties; for, while I am sure that operation has some influence on all cases, since, in our experience, it has never failed to help the purely toxic symptoms, yet its answer to our chief demand, the relief of the joint conditions, is disappointing in its uncertainty and frequently in the results obtained.

4. Even though I believe that a somewhat greater degree of danger is attached to the performance of colectomy, yet I should at present advise it rather than a simple short-circuiting operation, because of Smith's excellent results with the former as a primary measure, and still more because of his successful use of it as a secondary procedure in cases uninfluenced by a previous ileosigmoidostomy.

5. In no case, whether or not operation is considered, should such general measures as outdoor life, proper diet, exposure to sunlight, etc., be neglected.

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ABSTRACT OF DISCUSSION

ON PAPERS OF DRS. MAYO AND BOTTOMLEY

DR. REA E. SMITH, Los Angeles: The two postoperative complications which arise most frequently to spoil the success of a Lane operation are (1) backing up of fecal matter into the cecum and (2) unusual postoperative adhesions. The most frequent cause of failure in Lane's work is the unusual development of postoperative adhesions. The symptoms usually become manifest about the end of the first year after operation. At that time the patients may have a relapse and, as a result of the narrowing of intestines by the contraction of adhesions they may have more stasis than they had before the original operation. These adhesions are due to infection at the time of operation. The Lane procedure is open to a technical criticism. Lane sutures through and through the infected colon wall—the infected silk soils his gloves as well as the abdominal packs which it touches—thus rendering the whole field unsterile. The same infected hand then goes into the pelvis and lifts up the small intestines so that the split in the mesentery can be stitched. The adhesions we find on secondary operation after Lane's short circuiting operation are in patches, widely disseminated patches of local peritonitis due to infection at the time of the original operation. Recognizing this fact it is possible to do a short circuiting safely. The operation should be changed so that the colon is opened last and the field treated as infected from that time. In the Mayo right-sided colectomy the abdomen is not invaded after the colon is opened. The Murphy button is used and there is much less likelihood of infection and therefore of failure due to adhesions. I reported fourteen operative cases of arthritis last year. I am not as enthusiastic now as I was at that time. Twelve patients are living, three of the twelve are perfectly well at twenty-eight, twenty-six and eighteen months following operation. The patient, whom I showed here last year as a cure at the end of fourteen months, had to be reoperated on two months later for acute obstruction in the ileum due to postoperative adhesions. Because her obstruction was high she did not have a return of her joint symptoms, and she has had no return since. Her abdomen was full of adhesions from patches of local peritonitis following the Lane short circuit operation. Of the remaining ..ine cases in the series, two show no change; the other seven are all better than they were a year ago, but they have not gone on making the rapid spectacular recovery that the other three have made. None of them would go back to their former condition, because of the improved general condition and freedom from pain.

DR. W. R. MACAUSLAND, Boston: My experience with this procedure is based on a series of ten patients in whom the routine methods of treatment had failed; that is, no source for the infection could be found in teeth, tonsils,

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sinuses, kidneys, etc., and furthermore their intestinal symptoms were not relieved by the ordinary medicinal means. I cannot but feel strongly that the source of many arthritic conditions is to be found in the intestinal tract and the large majority of chronic arthritis cases have been unrelieved by the ordinary methods because this has been overlooked. In spite of the removal of tonsils and drainage of foci at the roots of teeth, most of these joint conditions are slowly progressive. There are all stages from the initial infection to the stage showing much destruction of cartilage with great disability and obviously in order to effect any substantial relief treatment must be inaugurated early in the course of the disease, before severe joint changes have occurred. When making a comparison of results by various methods we must make allowance for the joint changes which have taken place in each case. It may be well to call attention to the fact that the so-called "toxic arthritis" is coming more and more to be considered in this class. "Toxic" as a term must be restricted to such changes as are found without the presence of organisms, and in which it is reasonable to suppose no organisms are present. Those arthritic conditions resulting from chemical changes from disturbed metabolic conditions are also strictly omitted from consideration in this discussion. It is well known, however, that chemical, toxic and bacteriologic changes frequently give approximately the same findings; that is, one may have a destructive process accompanied by some form of exudate from any of these causes. It is well to consider all cases of polyarthritis, progressive in nature, with all signs of an active process in and about the joint, as being actually infected with organisms metastatic from some focus, known or unknown. The ten cases operated all presented intestinal symptoms and chronic constipation. It was observed frequently that slight exacerbations in the disease were due to an acute intestinal upset, accompanied by temporary diarrhea. The ordinary signs of intestinal stasis were present in all. Following the failure of ordinary methods and after demonstrating an actual ileostasis as being present, these ten patients were referred to Dr. Bottomley for a surgical correction of their intestinal condition.

Dr. Jerome Morley Lynch, New York: With reference to the so-called ileocecal valve: It seems to me that this segment of the intestinal tract being in the limelight it is about time that we come to some conclusion as to whether it is a muscle or a valve. If a muscle, then no operation can possibly be of any benefit. If a valve, then operation, if one follows Nature, will probably prove useful. It seems remarkable to me that the wonderful paper of Elliot has been overlooked for seven or eight years, because it must be at least that time since the paper first appeared in which he made a number of very exhaustive and accurate experiments with regard to the value of this segment of the gut.

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I think he has shown conclusively that this is not a valve but a muscle. We have been able to show on humans that by the injection of ten minims of epinephrin you can shut a so-called leaking valve as tight as a drum. Thus some patients were examined after barium enema and the insufficiency was promptly corrected for several hours by epinephrin. The connection between the internal secretions and the mechanism of this muscle is very important. What the relationship is we do not know as yet. Draper and I consider it probable that the Bauhinian valve has about the same value to the economy as the ureterovesical, which we have shown to be about 10 per cent.; the neuromuscular control being 90 per cent. Dr. Stockard of Cornell proposed for this operation of Dr. Mayo's the term "developmental reconstruction." It means something definite. It means placing the colon in a position that it occupies when rotation occurs at about the third month of fetal life. We have performed this operation twenty-eight times in all. First, for primary cancer of the ileocecal sphincter, for segmental polyposis, for dysmorphia of the elbow-deformity type at the hepatic flexure. We have performed cecosigmoidostomy six times. Every case has failed. We have done cecocolonic plication in seven cases, simply for comparative study.

Dr. J. E. Tuckerman, Cleveland:. I would ask a question of Dr. Mayo. On what can he base the statistics or percentage of operability; what is the standard on which he bases a percentage of operability? How can he compare percentages of operability between one surgeon and another since his own opinion as to what is and is not operable is undergoing a change? Is the operability based on the mechanical feasibility of doing the particular procedure or on the judgment of the surgeon as to whether that particular procedure is justified?

I was surprised in the discussion to learn that all adhesions are due to infections. Dr. Smith made that statement. I think it is hardly possible Dr. Smith means that.

Dr. J. S. Horsley, Richmond, Va.: Dr. Lynch has spoken of the ileocecal valve being a muscle and he says that he proved this by injecting epinephrin in cases in which the ileocecal valve was incompetent and found that it caused contraction and closure of the valve. Cannon and other physiologists have shown that while epinephrin causes contraction of the smooth muscle in the systemic blood vessels of the limbs and surface of the body it not only fails to cause contraction of the smooth muscle of the intestine, but actually relaxes it. In fact, one of the most delicate tests for the presence of epinephrin is the relaxing effect it has on a segment of small intestine when attached to a recording apparatus.

Dr. J. W. Draper, New York: Epinephrin will relax the musculature of the small intestine, but contract that of the

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ileocolic sphincter. If it is given hypodermically to an individual showing insufficiency of the sphincter it will normally close that sphincter. Failure to do this may be a means of differentiating between functional and mechanical derangement of the region. Dr. Lynch and I resected the right side of the colon. The woman was 50 years of age, was in the terminal stage of arthritis, in constant pain, unable to turn over in bed, unable to use her knife and fork, unable to write. The extraordinary thing was that within twenty-four hours from the colonic reconstruction that woman could turn over in bed and she herself commented on it. In three days the pain was gone and she was able to sleep without hypnotics. The rapidity of this clinical improvement suggests to us that there is a change in the biochemistry of the intestinal epithelium, perhaps throughout the canal, which accounts for the improvement, for it is impossible to believe that an interference with bacterial migration through the gut wall by operative removal of a diseased segment can be the only source of the improvement. Only those cases should be treated by developmental reconstruction of the colon in which the most scrupulous study had excluded all other sources of infection. It would be deplorable for this operation to come into general use for the treatment of arthritis.

Dr. J. E. Johnson, Memphis, Tenn.: Dr. Mayo's operation has several advantages. The end of the colon cannot drop down, hanging from the omentum, thus forming a pouch. He saves the omentum, which has the advantage that there is less danger of adhesions. His technic is good; there is less danger of infection. We become bewildered with the many theories advanced as to the cause of a condition which necessitates colectomy. Let us look at just what we find. It is obvious that the trouble is in the ileocecal region. On one side of the ileocecal valve we have the ileum, the great absorber; on the other side the cecum or sewer. If we have the contents which have been retained for too long a time in the cecum, regurgitated into the ileum, what is the result? We have a putrid material, about one-half by weight bacteria thrown into the great absorber. We have a toxic poison plus a bacterial infection. The colon is built for a sewer and its mucosa has its natural defenses against the contained bacteria. The ileum is built for an eater and has no such defenses. From the toxic poison we get a splanchnic paralysis, which is just as characteristic of this condition as drop wrist is of lead poisoning. From the bacteria absorbed in the ileum, the chronic infection, a terminal ileitis and a pericolitis, result, to combat which Nature builds stronger defenses, consisting of veils or membranes. These membranes when rotated gather together in strong bands. These membranes contract as all inflammatory tissues will, and secondly, we have the distortion. It will be noted

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that this condition appears at no other location; they are all alike only in degree. I have not seen a case of these membranes without visceroptosis nor a case of visceroptosis without these membranes. I mean where I have examined the patients with the fluoroscope in the vertical position before operation. This seems quite significant. It will be noted that all of these patients have suffered from toxic sick headaches when they are pale, sweat and vomit. These headaches cannot be laid to any dietary indiscretion or the regurgitation through the imperfect ileocecal valve which causes the sick headaches in youth, and which later causes splanchnic paralysis and the formation of inflammatory membranes. We have done eleven colectomies for stasis, some right side and others to the sigmoid; we have anastomosed the ileum into the upper part of the rectum, by the end to side method of Lane. Ten of these patients are living and doing well. I should advocate a right colectomy in all cases in which there is no obstruction in the distal colon.

Dr. Charles Horace Mayo, Rochester, Minn.: If, when compiling the statistics for malignancy, we disregard the patients we have turned down, and those who either die immediately after operation or look forward to recurrences, and accept only those who are decidedly benefited by operation, we get figures which are not a very good basis for conclusions by others as to what may be done in these fatal conditions. Therefore, in Winter's statistics you must take into consideration all of the patients you see — any that you run across. If you do not operate, they are in the class of those who are going to die of the disease. We are trying to find out how many die of the disease and how many can be saved. Sometimes the Roentgen v is a wonderful aid. We have tumors of the liver, malignant involvement of the stomach, secondaries, extraordinary tumors that can be felt at the bottom of the pelvis by palpating the rectum, and extraglandular involvement in the supraclavicular fossa, so that many patients would be refused operative treatment whose condition needed something immediate. Taking the whole list and locating the disease at only one point, fixation, we used to say, meant contraindication for the possibility of cure. We now know that that is wrong and, therefore, when we do not find metastasis at a distance, we now at least explore all fixed tumors of the large bowel and make most extensive operations, knowing that if we do not do it, we are condemning the patients to death and suffering. Concerning some of the other points brought up, I believe the discussion has been very fair. It is unfortunate that sometimes in the development of the new things in surgery their use in therapy is too greatly condemned, so that surgeons are kept from doing work along these lines for those who are suffering, and no method has been developed as yet for their relief. I would like to see these innovations going on so that the men having the obsession be given sufficient amount of rope to either develop something or hang themselves.

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PERFORATED ULCERS OF THE STOMACH AND DUODENUM

RAYMOND P. SULLIVAN, M.D.
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Perforation of a gastric or duodenal ulcer is a most serious condition. The prognosis is extremely grave unless recognized early and quickly followed by direct and heroic treatment. Of all the acute maladies to which humanity is heir, none is more grave and none more spectacular when attended by successful treatment. The treatment is purely surgical. However, Moynihan[1] reports two cases successfully treated by medical means during the acute stage; but in each instance the cases came to operation at a later date. We occasionally hear of deaths from "acute indigestion," but proper investigation would prove, in the majority of instances, that there was a perforation of either a gastric or duodenal ulcer. This should not occur at the present time. The burden of diagnosis will rest with the general practitioner and, even though an accurate diagnosis may not be made, at least there are always sufficiently grave signs to demand a surgical consultation and intervention.

The etiology of perforation is that of ulcer in general plus its acute termination. It results from a local necrosis and may be due to trophic disturbances or bacterial invasions, or it may follow trauma. However, a previous chronic ulcer is usually present. The immediate cause of the perforation may result from one of many factors. In all series reported, muscular exertion, trauma, food or alcohol ingestion are given as the immediate factors conducive to perforation.

1. Moynihan: Abdominal Operations, i, 165.

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The series here presented will confirm this. That an infective process predominates seems to be shown by the fact that so frequently there is a two-cycle phenomena of pain. A premonitory pain of greater or lesser degree was present in fourteen instances in this series. I believe this is due to a rapid necrosis, causing peritoneal irritation and spasm and hence the pain. Just how long the peritoneum will hold against this process cannot be determined exactly. The "big pain" has followed on an average of eight hours in each instance.

The chief symptoms which lead to a correct diagnosis in these cases are: (1) pain, (2) tenderness, (3) vomiting, (4) rigidity, (5) history of previous ulcer symptoms, (6) anxiety and restlessness, and (7) increasing pulse and rise of temperature. This enumeration is considered in the order of frequency observed in the series here reported.

Pain is sudden and violent. Its character is variously described by patients as "sharp," "cutting," "burning," or "bursting and stabbing." The prominent characteristic is the fact that it is unyielding. Its localization is mostly epigastric and supra-umbilical. Its quick radiation at times to the right iliac fossa has frequently led physicians and surgeons to consider an acute appendicitis; but careful inquiry of its early appearance most frequently localized it in the epigastric and right hypochondriac regions. Its radiation may be in any direction. The prominent factor is that the pain is excruciating and increasing in severity to such a degree that the patient is unwilling to submit to much examination.

Tenderness is unmistakable. It is acute and easily elicited. When the case is seen early, a careful and gentle palpation will lead to a marked tenderness over the site of the perforation. The site of maximum tenderness in this series varied mostly in the gastric perforations. There were fifteen duodenal perforations, and in twelve of them the most tender area was in the right hypochondriac region. In three, the right

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iliac fossa was made out as the most tender area; hence the improper clue to a correct diagnosis. Of the five gastric cases the maximum tenderness was all epigastric, and in one of these it was to the left of the median line.

Vomiting occurs very early, either reflex or induced, and is a valuable symptom. Frequently it gives slight relief to the agony at first, but later only increases the pain. However, I cannot say that vomiting will lead to any positive sign; for it may be present in almost any abdominal condition. Eliot[2] reports two cases in which there was no vomiting at all. In this series of cases, both gastric and duodenal, vomiting occurred very early and in every case. The character of the vomitus varied with the amount of food previously taken and also with the site of the ulcer. In duodenal cases the vomitus was greater in amount than in the gastric cases.

The second symptom of greatest value is that of rigidity of the abdominal muscles. Its appearance is early and its increase always in proportion to the length of time following the onset of symptoms. Deaver[3] very aptly says, "There is no condition in which the upper abdominal rigidity is so early and so marked as in perforated ulcer." In our experience with these cases we have relied chiefly on the character of the pain and the amount of rigidity as the principal indications of perforation. The "boardlike" type is the most significant guide, and the fact that it is continuous points to a progressive peritonitis and hence is of great value as a diagnostic sign.

When a patient is seen suffering from so acute abdominal pain and has this characteristic rigidity, the history of previous indigestion of ulcer type is usually obtainable. In this series of cases only one instance is noted in which previous ulcer symptoms failed to be elicited.

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2. Eliot: Ann. Surg., lv, 594.
3. Deaver, J. B.: Posterior Gastrojejunostomy in Acute Perforative Ulcer of the Stomach and Duodenum, The Journal A. M. A., July 12, 1913, p. 75.

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In this case there was a history of trauma eight days before perforation and the patient was confined to bed, being treated for "contusion of the abdomen," following an injury. On the morning of the eighth day after the injury, he was informed by his physician that he could go about, but was warned against any exertion or violent exercise. The patient said he felt so good that he determined to return to work and did so. During the afternoon, while lifting a "heavy case onto a wagon" he was taken with the terrible pain in the pit of the stomach, which increased every minute and necessitated calling an ambulance. He was taken to the hospital and we operated three hours later, finding a perforated gastric ulcer on the anterior wall about 4½ inches from the pylorus (Case 12).

In all other cases the previous ulcer symptoms were present. In eleven a diagnosis of chronic ulcer had been made and all had been treated by medical means with the uniform result of temporary relief for a variable length of time. This would seem to indicate that surgical treatment should be instituted for chronic ulcer, if for nothing more than a prophylaxis against perforation.

In cases of so grave a nature one might expect that shock and its associated signs would be manifest. However, this was not found in this series. The patients, on the contrary, seemed to be in fairly good general physical condition. In only one instance, and that one was seen late, was there any evidence of shock. Yet these patients all presented an appearance of anxiety and restlessness which signified that some great calamity had taken place within them. Their attitude was one of intense suffering. But the average pulse rate in this series was 90. The average temperature was 99.8 F. The average respiration was 34. I consider the increased rate of respiration an objective sign of value, because of the attempt on the part of Nature to restrain the movements of the diaphragm, and thus lessen the pain. However, if shock is present, it is not a contraindication to immediate operation. If the patient presents signs of perforation, immediate surgical intervention is indicated, and every hour of delay decreases the chances of recovery to a marked degree.

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In Case 10 of this series the man arrived at the hospital fourteen hours after the onset of the intense pain. He was in profound shock, and exploration revealed a large perforated gastric ulcer with a general peritonitis. He received very little anesthetic and the perforation was closed. His reaction was good. He lived five days. A reperforation superimposed on his general peritonitis was the cause of his death.

It is a noteworthy fact that in this series not once is "absence of liver dulness" recorded. It is therefore considered that this sign is not as valuable as we might expect. However, in a series of cases recently reported,[4] "modification of liver dulness" was noted in 127 out of 175 cases of perforated gastric ulcer. The amount of distention which might cause the modification of liver dulness has frequently been attributed to the escape of gas into the peritoneal cavity. This will be true if the amount of gas is sufficient. However, it is my opinion that when there is an absence or modification of liver dulness the cause is chiefly that of a progressed peritonitis. Hence, if this condition can be made out, its value is simply that of an unfavorable prognostic sign. Numerous symptoms and evidences other than those mentioned may be found, but the time spent in eliciting them will only delay operation and hence increase the chances for a fatal outcome.

Given a patient who is taken suddenly ill with an acute cutting or piercing epigastric pain which is continuously agonizing and accompanied by a unique or marked rigidity of the abdominal muscles, particularly of the upper half, and from whom a previous history of indigestion is obtained, the most imperative indication is operation. Differential diagnosis may have scientific value, but the moral value is dependent on early operation. There is no excuse for delay in the presence of such symptoms. It is true that acute appendicitis, perforation of the gallbladder, acute pan-

4. Edinburgh Med. Jour., December, 1914, p. 461.

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creatitis and acute intestinal obstruction may give an almost identical picture. However, the treatment in each of these conditions will be early operation. It is, therefore, necessary that a surgeon should see these cases as soon as possible.

Between September, 1910, and March, 1916, it was my opportunity to operate in twenty cases of perforated ulcer. In this series there were fifteen duodenal and five gastric perforations. Death resulted in one case of perforated gastric ulcer. There were six females and fourteen males. The average age was 34 years. The average duration of acute symptoms before operation was about six hours. The treatment in each case was surgical.

In the gastric cases the site of the perforation was found to be in one instance (Case 2) on the lesser curvature and the treatment used was excision and suture closure.

In another case the perforation was on the posterior wall (Case 11) about 1½ inches from the pylorus. The attempt to close this, both by an approach through the lesser sac and by a transgastric method, failed and finally we did a pylorectomy and posterior gastro-enterostomy. This patient had been under observation and a diagnosis of chronic gastric ulcer was made. He was ordered to be prepared for operation, Nov. 29, 1913. At 8 p. m., November 28, he received a gastric lavage. At 4 a. m., on the 29th, he was taken with severe epigastric pain soon followed by vomiting which contained a good deal of blood-streaked mucus. At 6:30 a. m., a second and more intense epigastric pain came on suddenly and continued with increasing severity. I saw him at 7:30 a. m., and the boardlike rigidity of the abdomen was present with extreme tenderness in the epigastric region. He was quickly submitted to immediate operation. When the peritoneum was opened, a thin serous fluid escaped, but no blood clot or mucus. The lesser sac was distended and immediately opened. A large blood clot was removed, followed by mucus, blood and bile. The perforation was found to be about 1/16 inch wide and plugged with a clot of blood. Our attempt to close it was unsuccessful, and in view of his good general condition and also from the fact that the general peritoneal cavity was not soiled by food particles, we proceeded with the pylorectomy and suture posterior no loop gastro-enterostomy. Drainage was instituted and the wound closed from below upward to the drain. His convalescence was stormy for two days, but soon returned to normal. His condition today is excellent. He has gained 26 pounds and enjoys his food without any distress.

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In three cases (7, 10 and 12) the perforations were on the anterior wall. In Case 7, the site of the perforation was in the pars media and close to the greater curve or about 3 inches from the pylorus. In this case the history of acute pain was five hours in duration, and the vomitus contained a good deal of blood. When the peritoneum was opened there was an escape of gas and many blood clots, with a large amount of mucoid material and a few food particles. The perforation was small and closed by a purse string suture of chromic catgut with reinforcement by three Lembert sutures of fine linen. This was followed by a thorough cleansing of the abdominal cavity by means of the Pool-Kenyon sucking apparatus. A soft rubber tube drainage was inserted at the lower angle of the wound. The patient made an uneventful recovery. She has not been seen or heard from since Feb. 23, 1913.

In Case 10, the perforation was situated on the anterior gastric wall about 2 inches from the pylorus. The lumen of the perforation admitted two fingers. It was the largest that I have ever seen. The duration of symptoms was fourteen hours. The patient was in shock and presented all the evidences of a man rapidly dying from a general septic peritonitis. The abdomen contained an enormous amount of thick turbid fluid, with many food particles. Numerous gas bubbles were noted. A grayish white exudate covered the entire under surface and margin of the liver. Many loops of bowel were matted together by the same sort of exudate. The perforation was closed by two rows of sutures and covered by an omental graft. The abdominal cavity was thoroughly cleansed by the sucking apparatus, and drainage instituted. It was noted that the closure embarrassed the pyloric opening very much. However, because of the precarious condition of the man, gastro-enterostomy was not attempted. Drainage was placed at the lower angle of the wound and likewise in both flanks. The patient was in very good condition for three days. He retained all liquids, both by rectum and by mouth, and we were jubilant. However, he was a man accustomed to a full diet and on the fourth day got out of bed and attempted to take food from a patient across the ward. He was arrested in his attempt by the nurse. This displeased him very much and brought forth a vigorous complaint when seen on morning rounds. But he was not to go hungry. Somehow he managed to get word to his wife and she smuggled a piece of beefsteak to him that afternoon. Fearing detection, he must have masticated his meat very poorly and had finished about two thirds of it before he was discovered by the nurse. We did nothing when this was reported. However, about an hour and a half later he was seized with intense pain and vomiting. When his abdominal wound was examined by Dr. Coakley, the house surgeon, it was found to have been rup-

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PERFORATION OF GASTRIC AND DUODENAL ULCERS

Case No.	Sex	Age	Hours of Symptoms	Preoperative Diagnosis	Operative Findings	Operation	Drainage	Soft Diet After Op.	Dis. from Hospital	Result
1	M.	35	6	Pf. d. d. ul.....	Pf. d. d. ul.....	Perforation closed.....	Yes	9 days	22 days	Gained weight; no symptoms
2	F.	51	10	Pf. gast. ul.....	Pf. gast. ul.....	Excision and closure....	Yes	10 days	30 days	No disturb.; good health
3	M.	23	8	Acute append.....	Pf. d. d. ul.....	Closure and Gas.-Ent....	Yes	5 days	15 days	
4	M.	32	6	Pf. d. d. ul.....	Pf. d. d. ul.....	Perforation closed.....	Yes	8 days	21 days	Condition perfect
5	M.	22	4	Acute append....	Pf. d. d. ul.....	Perforation closed.....	Yes	8 days	24 days	
6	F.	41	4	Pf. gast. ul.....	Pf. d. d. ul.....	Closure and Gas.-Ent....	Yes	6 days	26 days	
7	F.	19	5	Pf. d. d. ul.....	Pf. gast. ul.....	Perforation closed.....	Yes	10 days	22 days	
8	M.	30	6	Pf. gast. ul.....	Pf. d. d. ul.....	Closure and Gas.-Ent....	Yes	6 days	20 days	
9	F.	26	5	Acute append....	Pf. d. d. ul.....	Closure and Gas.-Ent....	No	5 days	16 days	
10	M.	56	14	Pf. gast. ul.....	Pf. gast. ul.....	Perforation closed.....	Yes			Died
11	M.	59	8	Pf. gast. ul.....	Pf. gast. ul.....	Pylorectomy and Gas.-Ent.	Yes	10 days	28 days	Gained weight; good health and appetite
12	M.	25	4	Pf. d. d. ul.....	Pf. gast. ul.....	Perforation closed.....	No	7 days	14 days	Some distress
13	M.	38	6	Pf. d. d. ul.....	Pf. d. d. ul.....	Closure and Gas.-Ent....	Yes	6 days	24 days	Gained in weight; excellent health
14	M.	33	4	Pf. gast. ul.....	Pf. d. d. ul.....	Closure and Gas.-Ent....	No	5 days	21 days	Little gastric distress after eating
15	F.	38	7	Pf. d. d. ul.....	Pf. d. d. ul.....	Closure and Gas.-Ent....	Yes	5 days	23 days	Gained in weight; excellent health
16	M.	24	5½	Pf. d. d. ul.....	Pf. d. d. ul.....	Perforation closed.....	No	8 days	18 days	Some distress
17	M.	37	6	Pf. d. d. ul.....	Pf. d. d. ul.....	Closure and Gas.-Ent....	No	6 days	27 days	Excellent in every way
18	M.	29	9	Pf. d. d. ul.....	Pf. d. d. ul.....	Closure and Gas.-Ent....	Yes	5 days	25 days	Gained weight; good health and appetite
19	F.	41	5	Acute append....	Pf. d. d. ul.....	Perforation closed.....	Yes	9 days	23 days	
20	M.	22	4½	Pf. d. d. ul.....	Pf. d. d. ul.....	Closure and Gas.-Ent....	No	5 days	15 days	

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tured and that there was an escape of gastric contents. We reopened the entire wound and found that a reperforation had occurred. Some meat was found in the stomach and also particles in the abdomen. A rubber tube was inserted into the perforation and a gauze pack placed around its base, hoping for a gastric fistula. The patient died fourteen hours later of a general peritonitis.

In Case 12, the perforation was situated on the anterior wall about the junction of the pars cardia and the pars media. This case resulted from trauma and the perforation occurred eight hours after the injury. The immediate cause of the perforation was attributed to muscular exertion. On opening of the abdomen in the median line, the entire anterior wall of the stomach was ecchymotic. The perforation was very small in caliber. The adjacent stomach was quite adherent to the anterior wall of the abdomen. A purse string of chromic catgut was first used to close the perforation, and then three Lembert sutures of fine linen placed to reinforce the closure. After removal of the appendix, which was found to be chronically diseased, the abdomen was closed without drainage. This man had very little reaction, and left the hospital on the fourteenth day after the operation.

In the fifteen duodenal cases multiple ulcers were noted in only one instance (Case 18). The site of the perforation in twelve of these was on the anterior wall and in the first portion of the duodenum. In two instances (Cases 15 and 17) the perforation was on the upper border and close to the pylorus. In one instance (Case 13) the perforation was on the posterior wall and about 1 inch from the pylorus. The operative procedure in dealing with these cases was as follows: In ten cases (3, 7, 8, 9, 11, 13, 14, 15, 17 and 18) the perforation was closed by two layers of sutures. The abdominal cavity was then thoroughly cleansed, either by the sucking apparatus or by mopping out with gauze. This was followed by a posterior no loop gastro-enterostomy. Recovery in each instance was most satisfactory and without any marked degree of reaction or discomfort. In five cases (1, 4, 5, 16 and 20) the operative procedure was a simple closure of the perforation by two rows of suture and covering with an omental graft. This was always followed by a thorough cleansing of the abdominal cavity by means of the sucking apparatus or mopping out with gauze

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pads. In two cases (16 and 20) no drainage was used. In the convalescence of these cases it was noted that the patients suffered a great deal more pain and discomfort than those in which gastro-enterostomy was done.

In the operative procedure used in the series under consideration, routine doses of ¼ grain of morphin and 1/100 grain of atropin were given as early as possible after deciding to operate. The anesthetic in every case was ether by the open-drop method. The site of the incision was in most cases a midright rectus one in the upper zone. The method of Gibson[5] to determine gas by the use of water in the wound before opening the peritoneum was practiced in one case (Case 19) and proved very satisfactory. Gas bubbles were seen immediately after the peritoneum was opened, and before discoloration or disappearance of the water. The incision should be generous and thus permit of easy exploration and thorough cleansing of the abdominal cavity. To accomplish this cleansing, the sucking apparatus devised by Pool and Kenyon was used in the majority of cases. Its operation is simple and its results very satisfactory. Its advantage over mopping out with gauze is that there is less injury to the peritoneum, and hence lessened opportunity for the formation of adhesions.

The principal feature open to discussion in the operative procedure, when dealing with a perforation of a gastric or duodenal ulcer, is whether or not a gastro-enterostomy should be added, after the closure of the perforation. There are many opinions for and against. The most recent that has come under my observation is that of Gibson,[6] in which he says:

I reject gastro-enterostomy as a curative measure in this class of cases, notwithstanding that I have had very gratifying experience with it in the cure of chronic ulcers. I consider it unwise to do a gastro-enterostomy for a condi-

5. Gibson: Surg., Gynec. and Obst., April, 1916.
6. Gibson: Surg., Gynec. and Obst., xxii, 393.

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tion that is going to be cured anyhow. In a very small number of cases in which gastro-enterostomy may possibly become necessary, it can wisely be postponed until its indications are clearly recognizable. The small number of cases in which it may be necessary will probably be balanced by the number of cases in which gastro-enterostomy fails to prove satisfactory, either because it is improperly placed, too small (subsequent shrinkage), too large (a very disagreeable condition), or the rare but exceedingly grave gastrojejunal ulcer. Moreover, in dealing with acute perforations it seems wiser to do only what is absolutely necessary and not subject the patient, who may have to struggle with a possible peritonitis, to an unnecessarily long operation or risk spreading the infection by the performance of a gastro-enterostomy under imperfect aseptic conditions. The after history of this series of cases contains no instances in which we have had occasion to regret the omission of this step.

This is a clear, concise and positive statement. It has been made after a very practical and painstaking study of end-results. I regret that it was impossible for me to locate my cases in time to make Roentgen-ray studies. However, we have been able to interview most of them and we shall discuss the end-results at another time. The position of Dr. Gibson deserves serious consideration and will undoubtedly furnish a safe guide to any one who considers gastro-enterostomy too grave an operation to be done in the presence of a perforation. However, this attitude has not met with general practice. Eliot[7] presents a series of communications from numerous advocates. Among them are Bretano and Körte of Berlin; Krogius of Helsingfors; Petrén of Lund, and W. J. Mayo, Peck and Woolsey of this country. These men do not favor it as a rule, but depend on the factors of (1) a good physical condition of the patient; (2) the narrowing of the lumen of the pylorus by the closure of the perforation, and (3) the site of the ulcer being at or near the pylorus. Deaver[8] is more enthusiastic, and says that "the danger of infection of the lesser peritoneal cavity by gastro-enterostomy has been overrated." He goes further and considers the operation safe even

7. Eliot: Ann. Surg., lv, 709.

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after sixteen hours of duration of symptoms, claiming that at this time "it is simply a matter of dexterity."

In this series, gastro-enterostomy was added to the closure of the perforation in ten cases. In one it followed pylorectomy, making eleven instances. The factors that were taken into consideration as indication for the operation were: 1. The general condition of the patient would permit it. 2. The duration of symptoms was not over ten hours. 3. The site of the perforation was close to the pylorus, and closure of it seemed to narrow the lumen to a marked degree. 4. It was assumed that by its performance the period of convalescence would be materially shortened, a factor always worthy of consideration, especially among the class of patients we meet in the wards of our city hospitals. 5. We assumed that if there were multiple ulcers. gastro-enterostomy would diminish the possibility of a second perforation. We never started out with an idea of speed; in fact, our work in each case was deliberate and careful. The average length of time taken to do the gastro-enterostomy was between thirty-five and fifty minutes. In all cases in which this operation was done, we did not encounter any increase in infection. Neither did we have any reason to regret our procedure. The patients all made satisfactory recoveries and enjoyed their semisolid food with more relish than those on whom we did the simpler operation of suture closure. From this experience we feel that there is a place for gastro-enterostomy in the treatment of perforated ulcers of the stomach and duodenum. It is our opinion also, that in perforations at the cardiac end or on the lesser curve of the stomach, gastro-enterostomy should not be attempted. Either excision and suture closure, or simple closure should be the procedure in these cases.

In the consideration of the subject of drainage of these cases, we have come to do less of it. Especially is this true in patients operated on within four or five hours after perforation. Our method has been to

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drain the affected zone with soft rubber tubes. In only one instance have we used counter drainage. Our routine has been to drain through the original abdominal wound. At no time have we used the suprapubic drainage. By the aid of the sucking apparatus most of the abdominal fluid can easily be removed, and hence fewer and smaller drainage tubes need to be employed. However, in late cases, I would consider it unwise not to use sufficient drainage.

The postoperative care of these patients is important. The Fowler position and saline by rectum should be instituted immediately. In this series when gastroenterostomy was done, water was given by mouth in from ten to twelve hours after the operation. Four to six hours later, if the stomach remained quiet, they received milk or other fluids in increasing amounts. In the cases of simple closure of the perforation, nothing was given by mouth from thirty to thirty-six hours after operation. Then small quantities of water by mouth was allowed at frequent intervals for six to ten hours. If the stomach did not rebel, other fluids were administered in increasing amounts. All patients received an enema at the end of thirty hours and then daily for five days. At this point a cathartic, usually castor oil, was given. Soft solids were given the gastroenterostomy patients on an average of the fifth or sixth day, and increased as rapidly as possible. The simple closures did not receive this diet until on an average of the eighth or ninth day. The question of diet in the postoperative care of these patients has been the subject of considerable discussion. Gibson[6] very potently says, "It is about time that we get away from the fetish of underfeeding or of the particular value of certain kinds of diet," in the after-care of these cases. I agree with this in every way. Nothing can be more of a worry to a patient than to know that he must adhere to some certain kind of rigid diet for a long time. When the patient is discharged from the hospital he should be able to handle a regular diet.

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However, we have cautioned against the use of very coarse food and have endeavored to educate the patient to the fact that good digestion depends mainly on mastication.

In our attempt to compile the end-results in this series, we have not had the success desired. Most of these patients belong to a migrating class and hence it is next to impossible to locate them. However, we have secured information in twelve cases of the series (Cases 1, 2, 4, 10, 11, 12, 13, 14, 15, 16, 17 and 18). Of this number four (Cases 2, 10, 11 and 12) were gastric and the other eight were duodenal perforation. In the gastric cases there was one death, previously detailed. In the three remaining cases all report a gain in weight and freedom from pain. Patients 2 and 11 report that they enjoy good appetites and relish their food without any signs of stomach distress, either immediately after or later. In Case 12, which was traumatic in origin, the patient reports that he suffers with an occasional distress and considerable gas belching beginning twenty to thirty minutes after eating and lasting about ten minutes. In the eight duodenal cases, five (Cases 13, 14, 15, 16 and 18) had gastro-enterostomy done after the closure of the perforation. All report gain in weight and freedom from any distress or pain. They seem to enjoy perfect health in every way, and assure us that they are not worried about any recurrence of their trouble. We did not receive a similar encouraging report in the three remaining cases (Cases 1, 14 and 16) in which simple closure was done. Patient 1 says that he has intermittent spells of distress coming on three to four hours after eating and is always relieved by an alkali. However, he further says that these attacks are now less frequent and of shorter duration. Patient 4 has no complaint to make except that he is "bothered with gas after eating which lasts about one-half hour." Patient 16 was operated on, Dec. 6, 1915.

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We did a simple closure of the perforation, five and one-half hours after the onset of symptoms. No drainage was used. He had a small skin stitch infection and left the hospital eighteen days after the operation in apparently good condition. He was seen and interviewed, May 6, 1916, just five months after the operation. His history was that he enjoyed perfect health up to May 3, 1916. At this time he began to have rather an agonizing pain in the pit of his stomach, coming on about two hours after meals and accompanied by considerable sour regurgitation. Vomiting occurred twice. He refused Roentgen-ray examination or gastric analysis. However, by palpation and percussion there was distinct evidence of a gastric dilatation, apparently caused by some degree of pyloric stenosis. His appendix had previously been removed and we advised gastro-enterostomy. However, he elected to try his alkali once more.

CONCLUSIONS

1. The diagnosis of perforation of a gastric or duodenal ulcer should be made in the majority of cases, and the imperative indication is early operation.

2. In the treatment of cases of duodenal or prepyloric perforations, gastro-enterostomy can safely be added if patients come to operation within ten hours after the onset of symptoms.

3. Simple closure of the perforation without gastro-enterostomy is a safe routine, but later stenosis is more apt to occur.

4. Drainage can be discarded in early cases, especially if operation is performed within six hours after the onset of symptoms.

5. Early use of a liberal diet should be practiced.

6. A complete study of end-results is a necessity before any definite routine can be laid down.

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ABSTRACT OF DISCUSSION

Dr. Charles H. Peck, New York: Cases of perforation of gastric and duodenal ulcers fall into three classes: First, the acute perforation with considerable immediate leakage, the type of case which Dr. Sullivan reported; second, the chronic penetrative ulcers which are protected by inflammatory adhesions and never have any considerable leakage at one time; and third, the ulcers which leak from time to time, causing attacks of localized peritonitis, and soon becoming sealed and protected, falling again into the chronic group. A certain percentage of the cases classed as acute perforations belong in this third group. Perforations near the pylorus are apt to be accompanied by a considerable amount of inflammatory exudate and consequent narrowing of the pylorus. In this group the leakage is often moderate and the condition of the patient relatively good, hence gastro-enterostomy can often safely be added to the immediate closure of the perforation. The question as to whether gastro-enterostomy shall be done at the time of primary operation is an important one, and the indications laid down by Dr. Sullivan express my views very well. In the larger perforations of gastric ulcer with a good deal of immediate leakage I think it is usually unsafe to attempt to do a gastro-enterostomy, but in an ulcer near the pylorus or in duodenal ulcer with moderate leakage the operation tends to help toward the ultimate cure of the condition. I have seen closure follow without gastro-enterostomy in one case of secondary perforation of a duodenal ulcer. Dr. Gibson states that the perforation itself tends to excite a reaction in an ulcer which aids in its ultimate healing and for that reason he thinks gastro-enterostomy is never indicated. When the ulcer has perforated it is undoubtedly true that the acute reaction and inflammatory process around the ulcer tend to aid in its healing. At the Roosevelt Hospital we had between 1910 and 1915 about 30 perforated ulcers; two thirds were duodenal ulcers, one third gastric. In the duodenal cases we had no deaths from extension of the peritonitis; there were two deaths from complicating conditions. In the gastric group there were many large perforations in the center of a large indurated area, with excessive leakage and there were five deaths from extension of peritonitis which was present at the time of the original operation. In the early part of our series comparatively few gastro-enterostomies were done, but not so later. In studying the results we believe that the gastro-enterostomy did not add to the immediate mortality if the cases were properly selected. Early diagnosis and prompt operation are the keynotes of success. We are all agreed that the patients who come under observation and are treated within the first twelve or fifteen hours almost invariably recover, while in many of the later cases death occurs from extension of the peritonitis.

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Dr. John T. Bottomley, Boston: I do not agree with Dr. Sullivan in the matter of doing away with drainage, even in early cases. I have seen the pelvis full of a nasty, turbid, dangerous fluid one and a half hours after perforation of a small gastric ulcer. With that fact in view it is in my opinion unsafe to do away with drainage in any case. The placing of a drainage tube in the pelvis greatly increases the margin of safety. We all vary in the degree of our resistance to infection and no man can measure that degree before operation, and as a matter of safety I believe drainage should always be provided. I disagree also as to giving a liberal diet shortly after operation. I believe in keeping these patients on a low diet for a considerable time. They are usually not awfully sick. They recover quickly and there is no particular indication for liberal diet soon after operation.

I think a search should be made in all cases of gastric ulcer for the source of infection. We are coming to regard a large proportion of duodenal and gastric ulcers as an end result of infection in another portion of the body. This should be sought for and, if found, should be eliminated.

Dr. Harry D. Johnson, New York: Dr. Sullivan's series of cases proves two things: first, that the doctor who makes the diagnosis and refers the patient for operation is alive to the gravity of these cases, and second, that he chooses his surgeon well. If we get these cases early when we are dealing with a peritonitis due to the irritative character of the stomach or duodenal contents, all we have to do is to stop the leak and the alkaline secretions of the abdomen will neutralize the acid stomach secretion, provided there has not been the supervention of a bacterial peritonitis. At the end of twelve hours the picture changes—the chemical irritation has superimposed a bacterial invasion. The important thing is the character of the rigidity. They are so rigid that if you walk on their belly you would not sink in. The question of liver dulness as a symptom is a delay in diagnosis. That little bubble of fluid in the gastric angle is a late occurrence and should never be mentioned as a symptom of perforation of the stomach or duodenum.

Dr. Raymond Peter Sullivan, Brooklyn: The use of drainage in these cases is purely a matter of personal opinion. I cannot say just when the peritonitis will be septic. However, in dealing with early cases we assumed, from the general condition of the patient and the appearance of the abdominal contents, that the peritonitis present was chemical and hence limited our drainage as much as possible. The results justified our action. When these patients come to operation under ten hours after the onset of symptoms, the abdominal cavity should be cleansed thoroughly by a sucking apparatus in preference to mopping with gauze. Thus the adhesion band formation, so apt to cause secondary obstruc-

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tion, will be lessened greatly. I have never used the suprapubic drainage. Our method has been to drain from the lower angle of the abdominal wound. Counter drainage was used in only one case.

It is just possible that in Boston the food may differ from what we eat in Brooklyn, and hence they see more constantly the sign of "absence of liver dulness." We have never recorded this condition. If it were present I consider it would be misleading, because so frequently a dilated colon will give modification of liver dulness. Perforation may occur at any time. If it occurs when the colon is loaded, fermentation therein may lead to modification of liver dulness.

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PLASTIC AND RECONSTRUCTIVE SURGERY

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Modern surgery is so vast a subject that no man can master it in all its branches. For this reason it has been necessary from time to time to separate, from general surgery, special branches which demanded special training, and better facilities for their full development. After a number of years' experience in plastic surgery I feel that the time has come for the separation of this branch from the general surgical tree.

The object of this paper is to advocate the special development and teaching of plastic and reconstructive surgery by those interested in it and trained for it.

I have heard many busy general surgeons say, "I do not like to do plastic cases, as they take too much time and require so much attention." These men will welcome the advent of the surgeon who is willing to devote his time to plastic work.

By plastic and reconstructive surgery I mean that branch of surgery which is distinctly formative or reparative. It deals with the repair of defects and malformations, either congenital or acquired, and with the restoration of function and improvement of appearance. This is accomplished chiefly by the transfer of tissue, either from the immediate neighborhood or from some distant part.

The deformities dealt with in plastic surgery for the most part involve the skin or adjacent soft parts, rather than the bones and joints, the ligaments or tendons.

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The healing of large denuded surfaces, and of intractable wounds, should also come under the care of the plastic surgeon. The field of plastic surgery is a broad one; the cases are numerous, and of varied types.

Orthopedic and plastic surgery approach each other quite closely in certain cases, but my experience has been that the orthopedic surgeon is glad to turn the plastic cases over to the plastic surgeon, and vice versa.

There is no single group of surgical cases which are more consistently "botched" than those requiring plastic and reconstructive surgery.

Plastic surgery is done by nearly every general surgeon in his routine work, and is often attempted by eye, ear, nose and throat specialists, and by those physicians who "operate only occasionally." I do not believe that it should be done as a routine by any one of these groups of operators.

It is well known that if any surgeon is interested in a special line of work, and gives his attention to it, he will in time be able to do this work better than the one who operates in these cases only occasionally.

It is imperative that the surgeon who expects to do plastic and reconstructive work should have a thorough general surgical training before attempting to specialize in this branch. Above all he must know, and thoroughly appreciate, the principles covered in the healing of tissues, and in the repair of wounds.

A special knowledge of the resistance and utility of tissues more or less infiltrated with scar tissue is also necessary, as in many instances normal tissue is unavailable. A knowledge of the surgical handling of children is very important.

Thorough familiarity with the free transplantation of skin, fat, fascia, bone and cartilage is essential, as all of these tissues are constantly utilized in reconstructive work. The principles of tissue shifting, and of the use of pedunculated flaps, must be understood,

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and also the possibilities of combinations with the above mentioned free transplants. An accurate estimate of immediate and subsequent tissue shrinkage must be planned for.

This work should not be undertaken unless one has a definite aptitude for it. A certain amount of imagination is also a very helpful adjunct.

To sum up the whole matter, in the words of Sir Frederick Treves,[1] "No branch of operative surgery demands more ingenuity, more patience, more forethought, or more attention to detail."

My experience has been that we seldom, if ever, find two plastic cases exactly alike, and thus no "cut and dried" methods can be employed. This endless variety in itself brings a certain fascination to the operative treatment, and to the after-care of these patients.

Each case requiring a reconstructive or plastic operation should be carefully studied, and the various methods of repair considered from every standpoint.

Keen surgical judgment is often necessary to determine what should be done; whether or not a plastic procedure should be finished at one operation; how far to go in the initial operation, and when to follow with the secondary procedures.

The results in certain groups of cases are very slow, and in these the process is one of gradual building up; in such cases the entire series of operations should be planned with regard to the ultimate result, and not to the immediate relief of the condition. For example, in some instances I have been able to gain only a fraction of an inch at a time in shifting flaps where the blood supply was doubtful.

The postoperative treatment and dressings should be done by the surgeon himself, or directly under his eye, as successful results in a great measure depend on skilful and judicious after-treatment.

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1. Treves, Sir Frederick: Manual of Operative Surgery, ii, 104.

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I am sure that all of us have seen patients with severe contractures following burns operated on in various clinics, with the result that at the completion of the operation the patient presented a perfectly sutured wound rivaling in appearance the schematic figures in the textbooks; and yet if these cases are followed in the wards, it is not uncommon to find that the beautifully sutured flaps, in which all the available material for repair has been used, have sloughed. Here, then, not only has the original condition not been bettered, but there has been superadded a disadvantage to the patient, and to the surgeon to whom he may drift later, that all the material useful for the repair has been wasted, and a longer and more tedious process has to be undertaken, with less likelihood of a good result.

In so many published reports of plastic cases, especially on the face, one is struck by the fact that while the original condition may have been rectified, the scar left by shifting a flap is as disfiguring as the original defect or even more so. Such a result, in many instances, shows poor judgment on the part of the operator, as the aim of the plastic surgeon must always be to repair the deformity with the least possible scarring of the surrounding tissues.

The purpose of surgical intervention in any branch of surgery should always be the cure of the patient. The primary consideration, first, last and all the time, must be the patient. This fact is sometimes lost sight of in the desire to operate.

If a patient with a certain type of lesion requiring surgical treatment comes to a surgeon who has not had special experience in the operative treatment of that particular trouble, it is the duty of that surgeon to refer the patient to some colleague who is known to be skilled in that treatment. This may not be "good business," but it is certainly for the best interest of the patient, and furthers true efficiency.

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In reconstructive surgery on the jaws and palate, the plastic surgeon should have the cooperation of a skilled dental surgeon. This combination has proved to be of inestimable value in France, and also in Germany, where the attempt has been made to concentrate as far as possible in certain hospitals those of the wounded who require reconstructive work on the face.

The plastic surgeon, with his special knowledge of tissue transplantation, can be of great use to the general surgeon and to the orthopedic surgeon in repairing the defects left by certain necessarily mutilating operations. This also applies to the gynecologist and genito-urinary surgeons, when called on to perform more extensive transplantations than these surgeons are accustomed to undertake.

The aim of the plastic surgeon is the relief of pain and deformity, the restoration of function, and, last but not least, of the ability to earn a living.

One occasionally hears the term "beauty doctor" applied to those doing plastic surgery. Although this term may have some foundation, as a matter of fact a very small part of legitimate plastic surgery is done for cosmetic reasons only. A number of patients have been under my care who previously were unable to secure even the humblest position on account of hideous facial deformities, and who, having been rendered presentable by a series of plastic operations, are now making a good living. If this is being a "beauty doctor," the title is worth while.

The tendency of modern surgery is toward increased efficiency, and anything that will improve results and advance the knowledge of surgical treatment should be given every possible opportunity for development.

It is only within the last few years that the surgeons especially interested in orthopedic surgery, in genito-urinary surgery or in cranial and nerve surgery have been allowed the necessary freedom required for devel-

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opment, and every one knows the wonderful advance which has been made in these branches.

In answer to the objection in certain clinics to any further splitting of the general surgical service, the following quotation may be of interest:

> The problem of establishing special surgical services in large general hospitals is always difficult, on account of the inevitable and natural feeling on the part of the general surgeons that such a procedure takes from them opportunities which are legitimately theirs. At the same time it is imperative that such services should be established, on account of the best interest of the patient, of medical education and of those surgeons who are devoting their time and energy to the acquirement of expert skill in special branches of surgery.[2]

Any progress in any subdivision of a general surgical service redounds to the credit of the whole surgical service, as well as to the special branch in which the advance is made. This fact is occasionally forgotten.

After this brief outline of the subject the question arises, Is the field of plastic surgery large enough and interesting enough to justify a surgeon in specializing in it? For myself I can answer unqualifiedly that it is. Furthermore, I believe that it is only a matter of time, and that the time is rapidly approaching when there will be created in every large surgical clinic a department of plastic and reconstructive surgery, under men especially fitted and trained for this work. Which clinic will be the pioneer in putting this important branch of surgery on an efficient and progressive basis?

ABSTRACT OF DISCUSSION

Dr. Emery Marvel, Atlantic City, N. J.: Dr. Davis's successes are due to his perfect technic, which ingrafting demands. The general surgeon relaxes and in many cases, perhaps, does not fulfil his whole duty. A man whose colon had been removed for malignancy and who was subsequently roentgenized, found himself with extreme destruction of the abdominal wall. The condition was so severe that he was incapacitated, but he refused operative procedures. From the

2. Surgical Specialties in Hospitals, editorial, Boston Med. and Surg. Jour., Dec. 2, 1915, p. 859.

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anterior superior spine on the left to the anterior superior spine on the right below and the costal margin on the right to 2 inches above the costal margin on the left was a window, including the skin, the fascia, and the right rectus muscle. Dr. Davis covered these immense areas with skin grafts and when I saw the man afterward, the epithelial repair was nearly complete and after six weeks the defect was entirely closed. The testimony is as to the extreme area in which successful skin grafting has been obtained. The average surgeon would not give sufficient time and attention to this work; hence it should be done by the specialist or one who has the patience for such a tedious procedure.

Dr. James Savage Stone, Boston: No branch of surgery requires more patience and detailed attention than plastic work. It requires also a very broad knowledge of the underlying principles of general surgery. There are two great groups of plastic work. The first deals with the various congenital malformations and defects; the second, with the results of trauma. In dealing with the congenital malformations there must be a thorough knowledge of the surgery of children and any one who undertakes the surgery of children must of necessity be able to treat well the various congenital defects, among which hare-lip and cleft palate occupy conspicuous places. A knowledge of the laws of growth is essential, especially of the growth of bone. Not only must we take account of the normal epiphyseal growth of bone, but also of the fact that bone grows to meet the demands that are put on it. There is no more striking example of this than the growth of a fibula which is transplanted to take the place of a lost tibia. This is a fortunate example of what nature can do to help the surgeon. The cessation of growth of the bones of the upper jaw and of the central part of the face may be a most unfortunate result of unwise operative interference with growing bone in operations for cleft palate. All these principles and many others must be understood in work with children.

Within the next few years there is going to be an immense amount of reparative work as the result of the war in Europe. Today the wounded men are constantly going back from the battlefields to the different hospitals in the big cities. When their primary wounds have healed so that they have become fit subjects for reparative work, and when the surgeons who now are more than occupied with the urgent life saving measures are more free, then the immense opportunities for reconstructive work will give those interested in this branch wonderful chances for study and teaching. Reparative surgery will become a part of the general medical preparedness of which we hear so much now. The immense amount of work to be done, and the facilities for study and for teaching will give to plastic surgery an even more important position than that it now holds.

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SARCOMA OF THE INTRA-ABDOMINAL TESTIS

WITH REPORT OF A CASE

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DENVER

This subject has attracted the special attention of a few recent writers in this country, notably Bulkley,[1] Coley,[2] Ewing[3] and Hinman[4] of Johns Hopkins. I am indebted to them for statistical and other interesting data.

Bulkley collects from the literature fifty-seven cases of sarcoma of the intra-abdominal testis; thirty-seven of the fifty-seven patients studied were single cryptorchids. Seventy-five per cent. of all the cases occurred in patients between 25 and 45 years of age, and 74 per cent. of the mortality occurred within one year after operation. The fatal progress was more rapid in the undescended than in the scrotal testis.

Hinman says that the malignancy is relatively more common in the undescended testis and this is the generally accepted view. Bulkley states that one in every four cases of malignant disease of an abnormally located testis is in the abdomen, and that there is one abdominal sarcoma to every fifteen sarcomas in the scrotum. Observations of others vary but little in this respect.

Ewing states that most testicular neoplasms originate in the sex cells and are primarily teratomas, and others

1. Bulkley: Surg., Gynec. and Obst., 1913, xvii, 308.
2. Coley, W. B.: Cancer of Testis, Ann. Surg., July, 1915, lxii, No. 1.
3. Ewing, J.: Teratoma Testis and Its Derivatives, Surg., Gynec. and Obst., March, 1911, xii, 230.
4. Hinman, Frank: The Operative Treatment of Tumors of the Testicle, The Journal A. M. A., Dec. 5, 1914, p. 2009.

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declare that all malignant tumors of the testis are teratomas or derived from them.

The teratomas and mixed types of tumor grow more slowly and in these cases the lymph glands are not involved so early. When the disease is in the right testicle the glands of the vena cava are the first involved in the metastases, and when it is in the left testicle the glands of the aorta are first involved.

Bulkley states that, in the forty-seven intra-abdominal cases in which operation was performed, only three of the patients were known to be living after two years.

Syphilis, tuberculosis and nonmalignant neoplasms of the abdominal testis are practically unknown.

Bulkley expresses the common opinion that spermatogenesis is lacking in the abdominal testis, but this statement admits of some qualification. He also says that transplanting into the scrotum does not improve it in this respect. This refers undoubtedly to the late operation in adult life.

Trauma is more common to the testis in its normal position, but it is not generally regarded as an important factor in the causation of malignant degeneration of the testicle.

Chevassu classifies all teratomas as cancerous.

With these preliminary observations, I desire to contribute one more to the brief list of reported cases of sarcoma of the intra-abdominal testicle.

REPORT OF CASE

The patient, L. W., was a miner, aged 37 years, married. He had never had any venereal disease. When 17 years of age, he had consulted a physician in regard to an undescended testicle on the right side, but nothing important was done, and the man had no discomfort or inconvenience until April, 1913, when moderate discomfort in the lower abdomen with dull pain and stomach indigestion caused him to seek medical aid. He consulted me in November, 1913, and a large abdominal tumor extending above the umbilicus and filling the lower abdomen was readily observed. It seemed to have a fixed point in the pelvis and admitted of but slight motion laterally. More frequent micturition was believed to

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be due to pressure on the bladder. The urine was normal and cystoscopic examination by Dr. Oliver Lyons showed no pathologic condition of the bladder.

The insidious and finally rapid growth connected with, as I felt, the intra-abdominal testicle impelled a diagnosis of sarcoma of the retained testicle. Its operability I doubted, but an exploration was decided on and, Dec. 6, 1913, at St. Luke's Hospital, assisted by Dr. Lyons, I opened the abdomen by a liberal incision in the middle line. A large, vascular appearing, solid tumor, with few adhesions to omentum or intestines, was apparent. The cornu of the right fundus of the tumor revealed a nodule the size of a hickory nut. The bladder was manifestly pressed downward or partially involved in the growth and could neither be seen nor felt. The hand in the abdomen posterior to the tumor discovered what seemed to be half a dozen nodules or enlarged glands connected with the growth at the base of the bladder. An aspirating needle was inserted into the middle of the tumor, and no fluid was withdrawn. With pressure around the puncture, a little grayish, brainlike substance escaped. Its sarcomatous nature seemed most probable.

The safe removal of the tumor being deemed most improbable, the abdomen was closed. The patient recovered promptly. On the third day, I commenced the use of the erysipelas and *Bacillus prodigiosus* toxin (Coley). I was determined to push it to the limit and to give it a fair and impartial trial. My assistant in the case (an accomplished genito-urinary surgeon) gave the patient a ninety days' lease of life.

The toxin, prepared by Dr. Martha Tracy of Philadelphia (Coley's formula), was administered three times a week. The dose, commencing with half a minim, was increased rapidly until a reaction of from 102 to 103.5 degrees of temperature was produced. At the end of one month, there was hardly a perceptible change in the growth, but certainly there was no increase. In seven weeks there was manifest decrease.

In February, 1914, the patient was given a few ordinary Roentgen-ray treatments by Dr. S. B. Childs. February 23, he left for Redcliff to resume his duties as foreman in a copper mine. I taught his wife and gave her written instructions with regard to the method and technic of giving the toxin. The patient visited me every two or three weeks for report and examination. This treatment was continued steadily with but two brief intermissions for eleven months. A written record was kept of his condition, chill and temperature especially being noted.

During this period there was not a single local infection from the injections, which were given chiefly in the loins and gluteal regions. Coley advises that the injection be made

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preferably in the tumor, but, when the lesion is within the abdomen, it is not safe to do this, unless adhesions to the abdominal wall are evident and sufficient to prevent extravasation and peritonitis.

It seems remarkable that even a naturally vigorous, healthy young man could work with hardly the loss of a day under such conditions, but it was made possible in this way: He went off duty every afternoon at 4 o'clock, and as soon as he reached home his wife, quite an intelligent woman, gave the injection. He immediately went to bed. Usually he had a chill followed promptly by a rise in temperature which not infrequently reached 104 and occasionally a little higher. In two hours the temperature would begin to decline at a rapid rate. He was then given a dose of quinin and liquid food. He slept very well the latter part of the night, and by morning was ready for breakfast and work.

The patient was very susceptible to the influence of the toxin, and during the eleven months, when more than 100 doses were given by injection, the maximum dose was 18 minims. In many reported cases of sarcoma, much larger doses have been administered with impunity in a short period of time. In this case it was continued faithfully and persistently, because the growth was steadily diminishing in size, and I hoped it would reach a point where it could be successfully removed.

In April, 1914, for three weeks, the injections were discontinued that I might observe the effect. I examined the patient at the beginning and at the end of this period and could not fail to observe, as did the patient and his wife, an increase in the size of the growth. The toxin was resumed and the tumor soon decreased in size. In August, 1914, the toxin was again discontinued with the intention of an early operation, the tumor being much smaller. In ten days the tumor was perceptibly larger. The patient came to Denver and I verified the fact. The use of the toxin was immediately resumed with prompt arrest in the increase of the growth.

Sept. 24, 1914, the patient called me over the telephone and stated that one leg was swelling. October 30, he came to Denver. Both legs were finally involved from the groins to the feet. The swelling was not due to phlebitis, but to lateral pressure of the tumor, or inflammatory tissue, on the iliac vessels. The patient was put to bed and his legs were bandaged. I now injected the toxin myself directly into the tumor to the depth of 2 inches, feeling satisfied that adhesions to the anterior abdominal wall rendered it safe. The reaction was much more severe and profound, and I found it necessary to reduce the dose to 50 per cent. of that usually given him. This was an interesting fact, showing a rapid and more extensive distribution of toxins into the system when injected into the tumor, which, in a weakened

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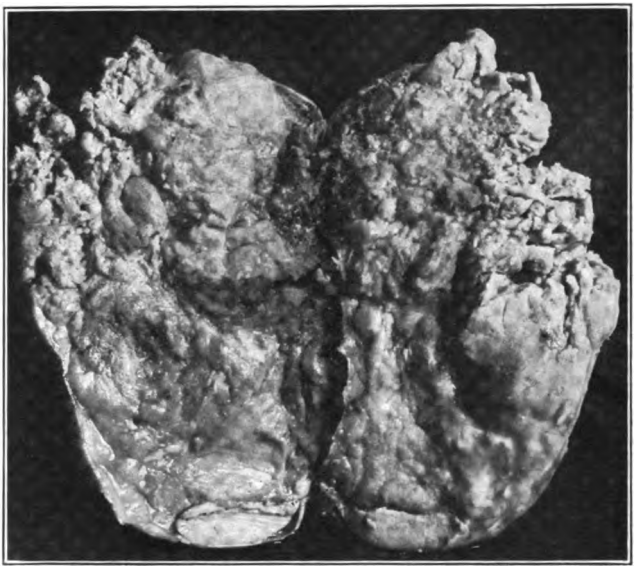

Fig. 1.—Gross appearance of neoplasm, diminished one third since operation.

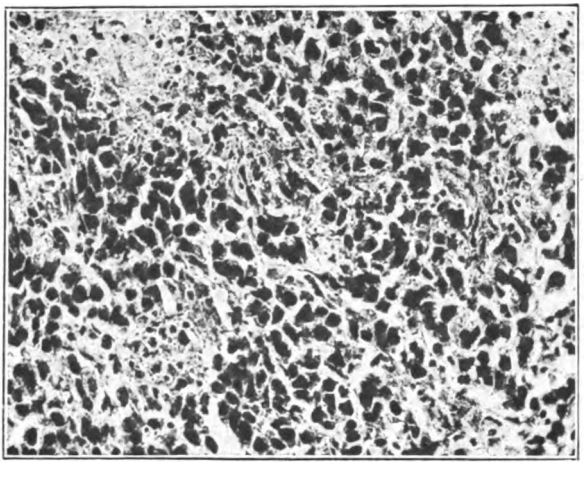

Fig. 2.—Typical sections of tumor showing large round cells and sarcomatous structure; stroma and vessel arrangement well seen. Zeiss apochromatic, 8 mm. Leitz projection ocular (R. C. Whitman).

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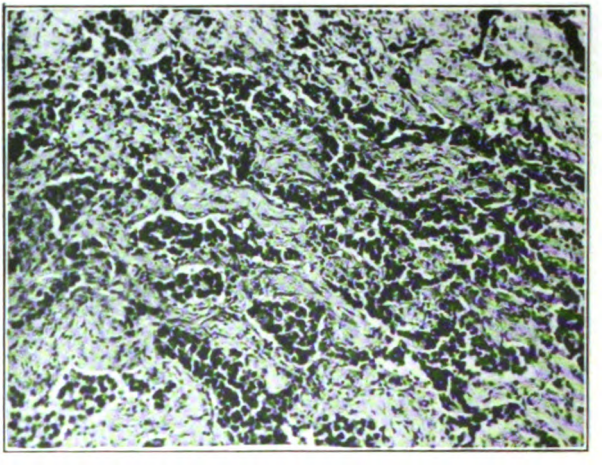

Fig. 3.—Carcinoma-like area, showing cell nests sharply differentiated from the connective tissue stroma. Zeiss apochromatic, 16 mm. Leitz projection ocular (R. C. Whitman).

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patient, might prove not only dangerous, but fatal. This method of injection was continued twice a week for five weeks, and during most of this time the patient was confined to bed on account of the weight and discomfort of his legs in walking. The swelling of the legs rapidly disappeared, and the tumor slowly decreased in size.

After Dec. 6, 1914, the patient was sent to the office of Dr. Childs for a series of Roentgen-ray treatments. Thirteen ordinary gas-tube treatments were given in December, 1914, while the Coolidge tube was used in serial treatment one day only in January, 1915.

During the year 1914, the tumor under toxins felt harder and more circumscribed on palpation. The Roentgen ray seemed to have the same effect; it also vastly increases, Dr. Childs states, the inflammatory adhesions connected with growths.

Jan. 30, 1915, with the assistance of Dr. Lyons at St. Luke's Hospital, I removed the growth completely and successfully.

The tumor and immediate surroundings differed in some respects from those observed at the exploratory operation, Dec. 6, 1913. The neoplasm was now quite uniform and regular in outline. The projecting nodular appearance at the fundus had disappeared. The adhesions in front had obliterated the peritoneum. The tumor was surrounded by a thick capsule of fibrous and connective tissue. Adhesions to the colon and omentum were extensive, but there were few to the small intestine. The inferior half of the transverse colon was buried by adhesions in the fundus of the tumor. Its safe dissection without damage to the integrity of the intestine was the most difficult part of the operation. The bladder, though adherent, was not involved in the growth. With the hand beneath the outer capsule, I shelled out the tumor, leaving the iliac vessels, on the right side especially, freely exposed. No lumbar glands were enlarged nor were any discovered about the base of the bladder. The large cavity left at the base and sides bled quite freely and it was necessary to pack it with gauze for forty-eight hours. It was then removed and a double rubber drain inserted. Necessarily such a wound would heal slowly, and, fortunately, adhesive ileus did not occur during the process.

The tumor was submitted to Dr. R. C. Whitman, pathologist of the University of Colorado, School of Medicine, who made the following report: "I regret to report that the tumor from Mr. Walker is a typical large round-celled sarcoma. It is also sometimes called carcinoma, mesothelioma, and malignant teratoma. This particular one is somewhat interesting in view of the fact that certain portions of it present a typical sarcoma structure, while others have some appearance of the usual carcinoma." This shows a mixed type.

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The patient recovered promptly and resumed his position at the mine in five weeks. A fistulous opening, extending to the full depth of the wound, remained for a year. This was attended with an annoying sequel and for a short time excited some apprehension. From the date of operation, January 30, the toxin was continued until June 24. At this time the patient was suffering from local infection of the fistulous tract and a small, deep, unhealed cavity.

Before leaving Denver, I injected bismuth paste to complete the healing. When the patient went to the copper mine, I showed him and his wife how to use it, and it was now the only treatment, injection being repeated two or three times, a week, but technic imperfect.

June 24, as indicated, he had a slight rise of temperature with headache. There were local swellings in the abdominal wall and the glands in the groin were slightly enlarged, suggesting metastasis.

I found the old fistulous wound infected. June 26, with a small nozzled syringe, I washed out the paste and pus with a dilute solution of hydrogen peroxid. The temperature was normal in thirty-six hours. The serial Roentgen-ray treatment with Coolidge tube was begun June 29 and discontinued July 5. I continued the irrigation with a 2 per cent. solution of liquor formaldehydi in glycerin for ten days at least. Improvement was continuous and the patient gained 37 pounds in weight in two months, and all local indications of disease disappeared in a short time. He has had no toxin since, and no Roentgen-ray treatments since July 29, 1915.

The improvement of the patient was so prompt and rapid that I felt this temporary setback was due to infection from the small pus cavity chiefly, but I attribute benefit to the use of the Roentgen ray. Its chief use, in my opinion, is after, not before, operation in any operative case.

The superficial veins of the abdomen were conspicuous for a year before operation. Their appearance today is nearly normal and so is the patient's general health.

He is 5 feet, 6½ inches in height, and weighs at this time 175 pounds. June 30, 1915, he weighed 137 pounds and his weight had slowly but steadily increased since the operation, January 30. The frequent use of the toxin with severe reaction, no doubt, operated to prevent rapid increase in weight.

COMMENT

Treatment of this condition is by radical operation, and its success depends chiefly on early recognition. The disease is quite insidious in its early stage, and unfortunately diagnosis is made usually at an advanced stage. Hinman places the operative cures at from 15 to 20 per cent. This is better than formerly recorded.

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Prevention is worthy of consideration. This can only mean the transplantation of the organ to its normal position in early life, or its removal in early adult life. Bulkley expresses the opinion that if only one testicle is undescended and the other is in normal position, the former should be removed; but if both are undescended the operation is not advisable, probably for certain assumed sexual or biologic considerations.

To assume that an abnormally placed organ is relatively more prone to degeneration or malignant growth is not, in my opinion, a surgical superstition, but is in accordance with sound biologic laws. Neither an entire organism, nor a part, develops as naturally in structure and function in an unhealthy environment. Decay or degeneration under such conditions is a natural response to the exacting demands of natural biologic laws.

The cure of an advanced case is exceptional and requires several years to determine. The mixed toxin in the case reported undoubtedly had a repressive or inhibitory, influence on the growth and progress of the tumor and must have been instrumental in promoting the disappearance of the nodular condition, observed in the exploratory operation, Dec. 6, 1913.

There should be no question as to the propriety and advisability of removing the testicle in early adult life in case only one is misplaced, whether the testicle is in the inguinal canal or within the abdomen. In the latter case, the Roentgen ray may be utilized in determining its location, if this is not revealed by palpation. If both are misplaced, one testicle being in the abdomen and the other in the canal, discretion and sound judgment would dictate the removal of the intra-abdominal testis, but not the inguinal, unless manifest disease of the organ demand it. The inguinal testis is always subject to observation and watching, the intra-abdominal never. It is, therefore, whether more prone to malignant change or not, the greater menace to life because of its secluded position, and of

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the insidious character of malignant disease and of the fact that the tumor has reached the point of great danger before it is observed.

ABSTRACT OF DISCUSSION

Dr. William B. Coley, New York: I believe the very remarkable result obtained by Dr. Grant was largely due to the excellent judgment which he exercised in the administration of the treatment, and to his perseverance in keeping it up for a long period. Dr. Grant has brought up a number of important points for discussion: First, the tendency of the undescended testis to undergo malignant degeneration. There is a very wide diversity of opinion on this point. Originally I agreed with W. McAdam Eccles, who held that there was no evidence of such tendency. My first twenty-five cases of sarcoma of the testis showed no evidence of an undescended testicle, the twenty-sixth and twenty-seventh both were of the undescended variety. In 1914 I reported 64 cases of cancer of the testis in which not less than twelve occurred in the undescended testis, and of these five were of the abdominal ectopia. Since I have observed six other cases none of which were of the abdominal variety. With regard to the treatment of this condition, I do not agree with Bulkley, who advocates the removal of every abdominal ectopic testis unless double. In cases in which the testis does not descend before the age of puberty, it is possible in nearly every instance to bring the testicle down into the scrotum by Bevan's operation. In rare cases in which the testis cannot be brought down, I believe it wiser to remove it rather than to place it in the peritoneal cavity. Inasmuch as antecedent trauma has been observed in about one-third of all the cases of sarcoma of the testis one would have to consider the operation of bringing the testicle down, as a possible factor in causing malignant degeneration. In one case which I observed there was good reason to believe that the trauma, incident to the operation of bringing the testicle down into the scrotum, was the immediate exciting factor in the causation of a sarcoma which developed shortly after the operation. On the other hand, in 281 operations for undescended testis in addition to nearly 100 cases which were operated on in other hospitals, no case of sarcoma developed after operation. The prognosis of sarcoma of the testis in general is very bad while that of sarcoma of the undescended testis is still worse. In view of the generally admitted hopelessness of malignant disease of the testis, there has been a strong tendency during the last two or three years, to advocate a very extensive and radical operation, consisting in the removal of all of the retroperitoneal and preaortic glands—a very grave operation and thus far attended with a mortality of 11 per cent. I

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hold the opinion that, it is unwise to submit the patient to such a prolonged and grave operation when the chances of saving his life by the operation are outweighed by the chances of death from the operation. I would propose the following method as a substitute to the radical operation just discussed: In primary cases, as soon as the diagnosis has been made, I would advise the immediate removal of the testis and cord, as high up as possible through the Bassini incision for inguinal hernia. Second, I would advise, beginning, as soon as the wound has healed, a routine prophylactic treatment with the mixed toxins of erysipelas and *Bacillus prodigiosus,* the same to be carried out for a long period of time, at least six months and in some cases a year. This treatment could easily be carried out by the family physician without interfering with the patient's ordinary occupation.

Dr. W. W. Grant, Denver: In reference to the post-operative treatment of these cases: If you will remove the growth completely these patients ought then to have some treatment of a prophylactic character. There are but two methods that we know of of any value whatever. One is is the use of the toxin made by Dr. Martha Tracy of Philadelphia and the other is the Roentgen ray. I believe these measures ought to be continued for a long time, for many months, if not for two or three years, because we never know when the patient has reached the period of complete cure. It may be three years, five or more. I therefore commend that feature always to your earnest consideration.

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PSEUDO-APPENDICITIS

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Fellow of the American College of Surgeons
OSHKOSH, WIS.

In a recent clinic (June, 1915) Murphy says, "We surgeons are not talking enough about early operation in appendicitis." That, I take it, depends on the audience. At such a gathering as this, one is justified in assuming that the question of acute appendicitis is settled, at least for the time being.

The method and time of treatment, and postoperative measures are practically uniform; delay in proper treatment is usually due to uncertainty in diagnosis, and the inexcusable estimated general hospital mortality of 10 per cent. is due to failure of some one to recognize well accepted principles of surgical diagnosis or treatment.

The question of chronic appendicitis calls for attention, not because of a high mortality rate, but because of a rather disconcerting morbidity rate, a postoperative persistence of symptoms. When a patient complains of the same symptoms after appendectomy as before the operation, there is sufficient reason for belief that the original symptoms were not caused by the appendix—that the treatment was based on an incorrect diagnosis. The large and apparently increasing number of these cases calls for close attention and an analysis of all available data, in the hope of arriving at some more definite justification for making a diagnosis of "chronic appendicitis."

In gathering material for such an analysis, I have reviewed my cases of unsatisfactory results following removal of the appendix, but have excluded:

A. Acute cases.

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B. Cases in which the appendix was removed during the course of an operation for other conditions.

C. Cases in which ordinary sequelae of laparotomy have occurred, such as hernia, ventral or inguinal, ileus, fistula, phlebitis, etc.

After excluding the foregoing those remaining are unquestionably due to mistaken diagnosis and may be divided into:

D. Cases in which the true pathologic lesion, and proper diagnosis, has been demonstrated at a subsequent operation, or is reasonably evident, such as gastric and duodenal ulcer, cholecystitis, pancreatitis, lesions of the genito-urinary tract, and of the uterus and adnexa, tuberculosis, syphilis, malignancy, orthopedic conditions, and spinal cord lesions.

E. Cases to which I shall direct attention, namely, those in which the persistence of the symptoms has not been rationally explained, and which might well be termed pseudo-appendicitis.

After excluding Classes A, B, C and D, I found between January, 1909, and January, 1916, records of eighty-seven cases in which the removal of the appendix, for chronic appendicitis, or interval operation for appendicitis, had not been followed by relief of symptoms; forty-eight of the eighty-seven patients were operated on by myself; 212 patients were operated on during this interval with such a diagnosis.

Forty-eight in 212 cases seems a high percentage of unsatisfactory results, and it is because of this fact, coupled with the paucity of similar reports on remote results in the literature, that the present analysis has been made.

REVIEW OF CASES

A review of these cases reveals:

Ages: Between 10 and 15, four; 15 and 20, sixteen; 20 and 25, twenty-one; 25 and 30, twenty-two; 30 and 35, ten; 35 and 40, eight; 40 and 45, three; 45 and 50, two; 50 and 57, one.

Sex: Female, 73; male, 14.

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Civil State: Married, 41; single, 46.

Fat, 21; thin, 41.

Duration of Symptoms Before Operation: "Some weeks," 4; half year, 7; one year, 9; two years, 5; three years, 6; four years, 5; five years, 6; six years, 4; seven years, 3; eight years, 5; ten years, 3; "for years," 23.

Number of Attacks: One, 6; two, 4; three, 2; four, 2; five, 1; six, 6; "many," 19; "repeated," 11; "yearly," 8.

Character of Pain: "Continuous," 16; "severe attacks," 23; "mild attacks," 26.

Tenderness, 25; rigidity, 9; hypersensitiveness, 39; sideache, 20; burning sensation, 14; colic: biliary, 9; renal, 5; lead, 1; ileac tumor, 8; acute ileus, 4.

Location of Pain: Right hypogastric, 10; epigastric, 20; umbilical, 8; right ileac, 37; left side, 7; "general abdominal," 14; lumbar, 8; "tender scar," 2.

Gastric Symptoms: Nausea, 52; vomiting, 24; "indigestion gas," 58.

Temperature: Elevated, 12 (two of these subsequently developed pulmonary tuberculosis); not elevated, 73 (subnormal temperature, frequent).

Bowel Movements: Constipation, 54; diarrhea, 2; alternating diarrhea and constipation, 7; normal bowel movement, 24.

General abdominal ptosis, 80.

Skin: Acne, 8; jaundice, 15; pigmentation, 12; hairy skin, 4.

Urinary Symptoms: Frequency, 16; suppression, 1; retention, 3.

Uterine Symptoms: Dysmenorrhea, 28; amenorrhea, 2; pregnancy, 5.

Nervous Symptoms: "Neurotic," 22; hysteria, 3; "spasms," 3; "fainting spells," 5; epilepsy, 1; aerophagia, 7.

"Neuritis" of: Arm, right, 12; left, 7; head, 3; breast, 4; foot, 1; painful heel, 2.

Right sided pain on exertion, 42.

Family History: Similar trouble in: mother, 5; father, 1; sister, 6; brother, 1.

Lack of equilibrium between the vagus and the sympathetic divisions of the autonomic nervous systems is plainly evident in the majority of these cases.

Miscellaneous: Congenital dislocation of hip, 1; talipes equinovarus, 1; strabismus, 4; high palatine arch, 1; intestinal parasites, 4; inguinal hernia, 6; femoral hernia, 3; umbilical hernia, 12.

Blood Examination in Seventeen Cases: Hemoglobin from 60 to 70 per cent., 2; from 70 to 80 per cent., 3; from 80 to 90 per cent., 8; over 90 per cent., 4.

Lymphocytosis, 5.

Leukocytosis, none.

Wassermann Reaction: Negative, 12.

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Spinal Puncture in Twelve Cases: Increased tension, 9; Wassermann negative, 12.

Gastric Analysis in Twenty-Eight Cases: Hydrochloric acid absent in 7 cases; increased in 10 cases; decreased in 5 cases; normal in 6 cases; stool, mucus in 9 cases.

Roentgenoscopy in Twenty-Two Cases: General abdominal ptosis, in all; double barreled ascending colon, 5; delay at terminal ileum with dilatation of cecum and ascending colon, 15; redundant sigmoid, 1.

Histology of appendix showed nothing characteristic.

Histology of glands showed simple inflammatory changes.

Culture from glands, negative.

Conditions Found at Primary Operation in Forty-Eight Cases: Appendix "normal," 6; appendix large, swollen, tense, erect, congested, 4; small appendix, 7; small fibroid appendix, 12; appendicitis obliterans, 2; small fibroid appendix "with adhesions," 9; mucocele of appendix, 1; retrocecal appendix, 6; fecal concretions, 12; free abdominal fluid, 10; enlarged mesenteric glands, 9; Lane kink, 6; general abdominal ptosis, 12; cecum mobile, 17; pericolic membrane, 15; perisigmoiditis, 3; double barreled colon, 2; hepatic flexure absent, 2; omentum adherent to left round ligament, 1; megaduodenum, 1.

Duration of Time After Operation Before Return of Symptoms: Less than six months, 39; between six months and one year, 27; between one and two years, 8; between two and three years, 4; between three and four years, 1; between four and five years, 1; between eight and nine years, 1.

Noteworthy Circumstances Which Preceded the Return of Symptoms: Husband in bankruptcy two years after operation, 1; business, law suit two years after operation, 2; pulmonary tuberculosis one year after operation, 1; three years after operation, 1; traumatism to abdomen a few months after operation, 1; "fell down stairs" six months after operation, 1; operation on mother one year after operation, 1; sudden death of husband one and one-half years after operation, 1; pregnancy one year after operation, 1; five years after operation, 1.

Conditions Found at Secondary Operation in Nineteen Cases: Lane kink, 6; double barreled colon, 8; general abdominal ptosis, 11; cecum mobile, 12; cecal torsion, 1; omental adhesions, 3; pericolic membrane, 12; perienteritis (ileal), 1; cholecystitis (noncalculous), 4; mesenteric glands, 7; adhesions between ileum and colon, 1; megaduodenum, 1; "adhesions" absent at stump of appendix, 19.

Secondary Operations: By author, 19; by others, 8; pericolic membrane, division of, 12; cecopexy, 8; Lane kink, division of, 6; omental "adhesions," division of, 3; perisigmoiditis, division of, 1; colectomy, 3; enterostomy, 1; ileosigmoidostomy, 1; cecosigmoidostomy, 1; cholecystostomy

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for noncalculous cholecystitis, 3; dilatation and curettage, 2; tonsillectomy, 2; operation for kidney stone (no stone found), 3; nephrectomy, 1; exploratory laparotomy, 1; hysterectomy, 1; Coffey's hammock operation, 1; gastro-enterostomy, 1; "retroversion" of uterus and ovarian cyst, 1.

Multiple Operations: Three, 4; four, 1; five, 2; six, 1.

Results of Secondary Operations: Unknown, 2; improved, 9; unimproved, 15; death, 1.

Results of Cases with No Secondary Operation: Unknown, 8; improved, 16; unimproved, 36. In three striking instances there was sudden spontaneous unaccountable recovery of health after a prolonged period of disability following secondary and in one instance multiple operation. Five improved after pregnancy.

SUMMARY

These cases of pseudo-appendicitis were usually in young thin adults from 15 to 30 years of age, more common in females, and about equally divided between married and single.

The duration of symptoms varied from "some weeks" to ten or more years. The number of "attacks" varies between one and six to "many," some recurring at regularly stated intervals.

The pain of attacks rarely put the patient to bed, though classed as "severe" in about one third and "mild" in one third of the cases. The pain is frequently described as "continuous" or "side ache" and made worse by exertion. Hypersensitiveness and tenderness are usual, and a "burning" sensation is frequent, but rigidity is not common.

Pain is usually located in the right iliac fossa, though it may occur anywhere on the right side, or at the umbilicus.

Tenderness at the scar of a previous operation is rare.

Temperature elevation is uncommon, subnormal temperature frequent.

Nausea is usual, vomiting rare, "indigestion" and "gas," frequent, with constipation present in two thirds of the cases.

General abdominal ptosis is very common, iliac tumor, gas tumor, dilated cecum and gurgling in the right iliac fossa almost constant.

Skin changes are variable, and urinary symptoms occasionally present.

These patients are frequently spoken of as "neurotic" in the history, and complain of "neuritis" in various parts of the body, usually on the right side. Goiter was present in a small proportion of cases.

Blood examinations show leukocytosis absent, lymphocytosis rarely present, the Wassermann in the blood, negative.

Spinal puncture in nine of twelve cases shows increased tension. The Wassermann in the spinal fluid is negative in twelve cases.

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There was lack of hydrochloric acid in the stomach contents in one fourth of the cases examined.

Mucus in the stool is not common.

Roentgenoscopy shows ptosis, and delay at ileum or ascending colon.

Sections of the appendix show nothing characteristic. The recent report of Muschowitz is of interest in this connection.

Mesenteric glands, on section show simple hyperplasia, and cultures from same are negative.

At primary operation in forty-eight cases the appendix was usually small, and with fecal concretions in one fourth of the cases.

There was free fluid in the peritoneal cavity in one fifth of the cases and enlarged mesenteric lymph glands in one fifth of the cases.

Ptosis, cecum mobile, Lane kink and pericolic membrane are not uncommon.

The primary immediate result of operation is very satisfactory, but there is usually a return of symptoms within the first year.

Trauma, pulmonary tuberculosis or "nervous shock" in some cases precede the return of symptoms.

Findings at Secondary Operation (in Nineteen Cases) by the Author: Adhesion of omentum or viscera to site of appendix is absent. "Adhesions" are uncommon; ptosis, cecum mobile and various membranes are constantly present. Mesenteric lymph glands are found enlarged in one third of the cases.

The remote results of various secondary operations are not encouraging: in twenty-seven cases, unknown, 2; improved, 9; unimproved, 15; death, 1. In sixty cases in which operation was not performed a second time, the results were: unknown, 8; improved, 16; unimproved, 36.

CONCLUSIONS

The existence of such a clinical entity as "chronic appendicitis" has been questioned.

Evidence presented shows that the diagnosis is often incorrect and is being made with unwarranted frequency.

After eliminating all demonstrable pathologic conditions that might possibly be confused with "chronic appendicitis," there remains, in certain cases, some cause for pain in the right iliac fossa, other than the appendix, the exact cause of which is as yet not definitely known.

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Such cases of pseudo-appendicitis are frequently associated with visceral ptosis, constipation and neurasthenia.

Appendicitis, either acute or chronic, or an appendix that has been the site of an unquestioned inflammation, calls for surgical treatment.

Pseudo-appendicitis, on the contrary, is in no way related to the appendix, and is a nonsurgical condition in which appendectomy is contraindicated; hence the necessity of a differential diagnosis between these conditions.

Every case of so-called chronic appendicitis that is associated with enteroptosis, constipation and symptoms of nervous instability should be looked on as pseudo-appendicitis until careful and painstaking study of the history and clinical findings prove it to be otherwise.

In patients unwilling, or unable, to submit to this careful differential diagnosis, the good repute of surgery demands that the facts, as to this uncertainty in diagnosis, and hence in the result of treatment based on such diagnosis, should be frankly presented to the patient or responsible relatives.

If it is then decided that the appendix shall be removed, the operation will be exploratory, a short cut to diagnosis, with the diagnosis and prognosis withheld until after the operation.

The diagnosis of chronic appendicitis presupposes a previous attack of acute appendicitis.

It is often impossible to determine the character of a previous attack of right sided abdominal pain, from the data available at a subsequent time, especially in view of the fact that cases of classical acute appendicitis with damage to the appendix, demonstrable at subsequent operation, are many times entirely free from all symptoms for long intervals.

Hence the advisability of seeing the patient in one of these attacks, the characteristics of which may clear up the case.

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Cases characterized by more or less continuous discomfort in the right side of the abdomen, or of mild attacks of short duration, with brief intervals of relief, in which the pain is made worse by exertion and with relief on recumbency, associated with hypersensitiveness of skin and spasm of muscle, gas tumor, cecum mobile, gurgling, nausea but rarely vomiting, normal or subnormal temperature, no increase in leukocytes, constipation, enteroptosis, and evidence of vagus irritability, leading sometimes to chronic invalidism, are often pseudo-appendicitis and are not permanently relieved by removal of the appendix. Such cases should, therefore, be given careful consideration before operative measures are instituted.

An entirely satisfactory explanation of this state of affairs has not yet been presented, though intensive study suggests that a lack of balance between the vagus and sympathetic divisions of the autonomic nervous system may be an etiologic factor.

This in turn may be due to abnormal function of some of the endocrine glands.

Much is to be learned regarding this clinical syndrome, but in the meantime accumulating experience strongly suggests the desirability of emphasizing the fact that the diagnosis of chronic appendicitis calls for more justification than is often given it.

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ABSTRACT OF DISCUSSION

Dr. H. A. Black, Pueblo, Colo.: There are but few structures within the upper abdomen disease of which may not give rise to symptoms which resemble those of chronic appen-

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dicitis. In chronic gastric disorders there is probably greater confusion than in any other condition within the abdomen as applied to chronic appendicitis. In these cases the Roentgen ray, the test meal, even hemorrhage from the stomach, does not and should not convict that organ of ulcer. The absence of pain and tenderness does not absolve the appendix from possible guilt. Of course, these cases can usually be demonstrated by operation, but it is much more pleasant to confirm rather than to be confounded by our operative findings. Pyloric spasm is probably the chief factor of confusion between chronic stomach disorders and chronic appendicitis. Pyloric spasm is very common in chronic appendicular disease, especially that form known as the obliterative type of appendix. Given a case of chronic peptic ulcer versus chronic appendicitis, there is required skilled surgical diagnostic ability as well as a very high degree of judicial temperament. The pyloric spasm will often confuse the Roentgen-ray findings; not infrequently it accounts for hematemesis and I believe it is probably the direct cause of so-called "hypersecretion" through retention of the natural gastric secretions, rather than that the glands of the stomach have actually produced an abnormal amount—a hyperretention rather than a hyperproduction. I would apply the same reasoning to the condition of hyperacidity when encountered in connection with pyloric spasm, for the contraction not only retains the secretion within the stomach but also prevents the regurgitation of the intestinal secretion which normally takes place and to a normal degree lessens the acidity of the stomach contents.

Dr. Ernest Laplace, Philadelphia: Long before the days of appendicitis we heard of trouble in the right iliac region called typhlitis. In fact most right iliac conditions were referred to the cecum. We now know that these troubles start generally in the appendix. As a result the cecum is now almost forgotten. At the beginning of the colon there are two pouches, one the appendix and the other the cecum. As the appendix can receive and retain intestinal contents, we have entirely neglected the cecum which receives and may retain, beyond the proper time, intestinal contents subject to all decompositions. Now the cecum is coming back into its own. When we operate and find the appendix and remove it because there is trouble there, we have possibly overlooked the real seat of the trouble, the cecum, and there may be, probably there is, a chronic form of transudation of toxins through the cecum which leaves no apparent trace of itself. We know that in cases of so-called recovery after a phlebitis on the left side, the insidious poison may have traveled from the right side to the left and we must conclude that there are toxins which leave no trace behind. It would seem that decompositions take place in the cecum which do not result in the necessary irritation which produces bands and adhe-

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sions and so on, but which does produce a neurasthenia which precedes or follows the enteroptosis, etc. I wish to make a plea against the very small incision in cases of appendicitis. We must explore. Because pain is there we must not conclude that it is due to the appendix only. The whole region should be examined in order to fulfil the indication and not allow a neighboring lesion to pass unnoticed.

Dr. M. Howard Fussell, Philadelphia: Dr. Connell advises what many of us cannot do, to differentiate between those cases which do not show any pathology and the actual cases of appendicitis giving rise to pain in the right iliac fossa. The reasons for this difficulty in diagnosis are appendix, gallbladder and gallduct disease; stomach conditions, kidney conditions and so on often are difficult and sometimes impossible to differentiate from true or apparent appendicitis. Now as he has suggested that all the pseudo cases, as he calls them, that is, all these cases of pain in the right iliac fossa which are *not* due to an inflammatory condition are frequently accompanied by splanchnoptosis and also practically all of the individuals, man or woman, are neurasthenic. The question of treatment is the great point. What shall be done in these cases. From the medical standpoint all such cases where the diagnosis of appendicitis or other abdominal inflammatory conditions is questionable or where it is fairly well shown that there is no inflammatory condition should be put on a diet which will fatten them, on rest that will keep them out of the turmoil of society, and a vast majority will clear up under that sort of treatment, but there still remains a certain proportion which does not clear up under such conditions. Tell the patient you are in doubt about the diagnosis. If you are a surgeon tell the man who sent you the patient that you are in doubt about the diagnosis, but the safest thing to do is to make an exploratory operation because with all our careful diagnoses there are a number of cases of inflammatory conditions which do give rise to pain in the right iliac fossa without the usual physical signs. It is a great deal better to open the abdomen and find nothing than to allow an old gallstone or a diseased appendix to remain with a possible serious result.

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SURGICAL ASPECTS OF INDUSTRIAL ACCIDENT INSURANCE

ILLUSTRATED FROM CALIFORNIA EXPERIENCE

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Legislation embodying into laws the ideas of employers' liability, workmen's compensation and compulsory industrial accident insurance in its historical development constitutes a sociologic movement of the greatest significance and of the widest application. It affects not only all communities in the states in which it has been adopted, but also all classes in those communities, profoundly influencing the cost of production of a great variety of commodities and in consequence the cost of living and material development.

This latest phase of the never ending struggle between labor and capital has brought forth an entirely new conception of at least certain relations of workman and employer to each other, to industry and to the public.

Because fundamentally this movement has to do with the health and physical welfare of the laboring classes, relations have developed with the medical profession in an altogether special sense. Broadly speaking, the law in its present form is largely designed to afford to the injured workman the best medical and surgical service available, and this is made a matter of social economy, an entirely new sort of enforcement of a principle long recognized as to the duty of surgery to restore the injured workman to his earning capacity at the earliest possible moment. I mean that the law

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has made it sharply to the pecuniary interest of a large body of men, the employers through the insurance carriers, to provide such surgical service for injured employees as will insure their return to productivity to the greatest degree possible and in the shortest possible time. This cannot fail profoundly to influence medical and surgical practice and medical education.

The problem of providing for the relief of workmen, their families, widows and orphans is a very old one, and attempts at its solution by organization date back even to the guilds of medieval Europe; but until the present movement was inaugurated, attempts at solution of the problem have always been from the standpoint of mutual aid on the part of workmen themselves or else on the basis of charity.

The principle of the state assessing the employer for the cost of medical and surgical aid and monetary compensation of injured workmen, making it a matter of law and right as opposed to charity, is of German socialistic origin, the first important legal expression of the same based on older Prussian laws being the German employers' liability law of 1871.

So revolutionary a principle could not be adopted except on an experimental basis, and therefore it was made applicable only to the more obviously hazardous occupations. It put particularly on mine owners the burden of caring for injured employees, and was based on fault; but the burden of proof of fault bore so heavily on labor that it signally failed of its object and resulted in little more than the engendering of a prodigious number of embittering suits at law. It was an entering wedge, however, and led directly to the compulsory industrial accident insurance laws of 1884.

Following the lead of Germany, yet often basing their practice on different principles and with variation growing out of accommodation to laws and customs already in force and organizations already active in the same direction, all the great powers of Europe and

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many of the smaller states have adopted laws more or less effectively solving the problems of workmen's compensation, employers' liability and social insurance. Austria in 1887, Hungary in 1891, Norway in 1894, Finland in 1895, France and Italy in 1898, Spain in 1900, Holland in 1901, Russia in 1904, Belgium, Switzerland, Sweden, Denmark, Greece, Serbia, Bulgaria, Peru and others, including even Iceland, have adopted and are enforcing such laws.

England passed the employers' liability act in 1880 and the workmen's compensation act in 1897, which provided that compensation should be made by the employer to the injured workman irrespective of negligence or contributory negligence and was made to apply to most industries. In 1900 the law was extended to agriculture and in 1906 to practically all persons in service. Moreover, certain industrial diseases were interpreted as "accidents" within the meaning of the law. The British colonies of New Zealand and those of Australia, Canada and South Africa followed suit.

Beginning with Maryland in 1902, one state of the Union after another, and the federal government have enacted laws for workmen's compensation. The original law in Maryland was declared unconstitutional, as have laws on this subject in other states; but by a process of experimentation and amendment, laws more or less satisfactory in solving the problems of workmen's compensation have been evolved and are now in force in thirty-one of the forty-eight states, while some others have the matter seriously under discussion and in the hands of commissions for investigation. The federal law of 1907-1908 was far in advance of any state law in force at the time of its enactment. It is still in force and extended by amendment till it is now applicable to employees of the government on the Panama Canal and on the Alaskan Railroad and employees of corporations engaged in interstate commerce. It is, however, based on fault.

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In 1910, New York took the lead in enacting a liability law of general application which has been followed by a great number of states in its essentials, though modified to meet local requirements and legislative ideas.

For the purposes of the present paper it is important to note that in nine states, California, Colorado, Maryland, Michigan, Montana, New York, Pennsylvania, Ohio and West Virginia, there is maintained a state insurance fund. In the seven states first mentioned the state fund actively competes with private insurance companies.

Nearly all the countries of Europe now include compulsory insurance of the working people against illness. "The cost of insurance is usually distributed between the worker and the employer, and in some countries the government also contributes a share. By this device the employer is compelled to bear some portion of the cost of sickness among his employees, and the worker receives larger benefits than he could purchase unaided."

Notwithstanding the dismay of the medical profession in England when this law of compulsory insurance of workmen against illness was first promulgated (1911) which was marked by a veritable strike of the British Medical Association, the law is being enforced and the fears of loss of income which actuated the medical men have not materialized, being more than neutralized by the realization of the previously inadequate medical care the laboring classes received and the consequent increase of volume of professional service provided under the new law. The fact is that the incomes of a great body of medical men in Great Britain have increased as a result of enforcement of the law, and more adequate medical and surgical service has been rendered the working classes, although the quality thereof is criticized as not having improved in proportion.

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It is not possible to foresee the limits to which this movement may continue in this country, but it is only a short step from industrial accident insurance now effective in thirty-one states to compulsory insurance of workmen against accident and illness in all of the states. There is much difference of opinion as to whether the whole matter should not be taken over by the federal government and the law made uniform throughout the country and be enforced by a government bureau. Against this view is the practical fact that in thirty-one of the forty-eight states there is already provided most of the machinery required for the economical enforcement of such laws, machinery which is more attuned to local conditions than a federal bureau is likely to be. On the other hand, the general government would be less likely to go to the extremes of socialism which many foresee as the logical conclusion of present tendencies in state legislation.

A movement so widespread over the world is not to be checked; it must continue to spread and to develop, and must be reckoned with as a permanent sociologic institution in which the medical profession is deeply concerned.

Some conception of the effort the laboring classes have made by mutual insurance schemes against sickness and other risks may be obtained from a study of the so-called friendly societies historically traceable to the guilds.

Naturally in such schemes insurance against sickness took a prominent place, and until with the development of modern methods in manufacture, the use of steam and electric power, the use of complicated and often fast running machinery, of explosives, etc., sickness was a greater risk than industrial accident.

In the latter part of the nineteenth century, friendly societies increased greatly in numbers all over Europe. In England alone a few years ago there were 25,000 such societies with a membership of about 6,000,000. They insured against a great number and variety of

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risks — sickness, accident, old age, decrepitude from other causes, loss of employment, death, loss of a workman's tools, additions to the family, funeral expenses and in some cases even wedding outfits.

The great increase in such societies was an effort to meet the changing conditions of modern employment, and was in effect a protest against the inadequacy of the law in protecting wage earners and people of small means against losses which were often the cause of the complete submergence of these people in abject poverty.

Such organizations, having little capital back of them, were often not financially sound, and hence were not altogether reliable in affording relief. In Germany in many instances it was made a matter of contract and later of law that the employer contribute a certain proportion of the funds.

REDRESS UNDER THE COMMON LAW

In England, previously to 1880, the date of the passage of the employer's liability act, aside from the benefits to be derived from membership in the friendly societies, the injured workman could seek redress from his employer only under the common law, and the same was true in this country, whose fundamental law is based on the English common law, and is still true in some states.

Under the common law an injured employee could claim compensation from his employer only when the accident could be shown to be due to the fault of the employer, against which contributory negligence, common employment and contractural assumption of risk successively became valid defense.

As long, however, as industries were carried on on a small scale, the employer of a few men, working generally alongside of his employees, the common law rules were comparatively satisfactory, but with the development of industries on a large scale, especially under control of great corporations, the relations

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became so complex that liability based on fault was most difficult to establish, and the defense of contributory negligence and common employment became so effective as to work an intolerable hardship on injured employees, who not only had to bear practically all the risk of physical injury but most of the monetary risk as well, although they were least able to do so.

Under the common law, medical and surgical service to injured and sick employees was on an even worse basis. Men with incomes under $1,000 a year had little margin from which to provide premiums for life or other insurance, and little to pay for medical and hospital service, especially when, as was too often the case, the bread winner was the one sick or injured. They were forced to take advantage of free clinics and charity hospitals with the attendant humiliation, the distaste for which would often lead a self-respecting man to consult a physician, pay what he could and then run up a doctor's bill of such size as to make the honest workman the debtor of the doctor for the rest of his natural life. Or, finding himself unable to pay, he would let the bill run on till written off the doctor's books. Again he would join a lodge or a "hospital association," or, which is not much worse, make his own diagnosis and fill his stomach with "patent medicines" and his closet shelves with the empty bottles.

Medical and surgical fee bills established by local medical societies in various communities based on the average incomes of the so-called better or at least more prosperous classes in those communities provide charges altogether out of reach of such workmen; and while most medical men do a great deal of work without monetary compensation, and many permit patients with small incomes to pay what they can, only too frequently is the reverse the case, and charges made which are altogether impossible of payment without serious sacrifice on the part of the patient.

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Under the common law system, large employers of labor often find it advantageous to employ on a basis of contract one or more physicians or surgeons to care for their employees, the expense in most instances being paid out of the funds created by withholding from the wages of each employee a small sum each month, generally $1, out of which also is paid the cost of hospital maintenance. Such positions of contract physician are often sought after by young medical men because thereby they are insured a living and have opportunity of adding to their incomes by doing more or less private practice in the vicinity.

This form of medical and surgical relief of workingmen answers well or poorly according to the quality of the medical man employed. Often the salary paid is too small to attract a competent man, and, again, the "company doctor" is sometimes appointed because of social favoritism rather than fitness. In general he is a sort of agent of the company whose business is the corralling of evidence which might be produced in court in defense of any action for damages the injured employee might later inaugurate, services which are apt to be looked on at company headquarters as being quite as important as the purely professional duty of attending to the patient and alleviating his suffering. He is expected to neutralize as far as possible the pernicious activities of the "ambulance chasing lawyer."

Under this system, there being no provision for the payment of indemnity for the disablement of an injured employee, the company is interested only in providing first aid and surgical and hospital care during the acute stages of illness. Except as a matter of charity it is not interested in end-results. And yet end-results are the particular things with which the injured individual and the industry as a whole are vitally concerned. A man maimed is lost to the industry and becomes a burden on the community. Moreover, it is estimated that the average cost of breaking in a new hand is $35.

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Although industrial accident insurance has been in force in California only two years and a half, it has done much to lessen the evils of contract practice, and many concerns have already ceased the practice of employing physicians on contract.

The friendly societies or fraternal organizations or lodges which, as said above, have increased so prolifically during the last fifty years, are organized largely to afford medical and surgical services at such cost as to be within the reach of the laboring classes, the monthly dues providing the means for the employment of community physicians. Many such, however, extend their membership to include people in much more comfortable circumstances, who join for the purpose of securing cheap medical and surgical service.

The medical profession, therefore, finds itself opposed to what it considers exploitation of the profession. While from the standpoint of cheapness this scheme works well enough for the members of the societies, it often — in fact generally — fails to secure to the patient competent medical service. Investigation has shown that in these societies the payment to the doctor is far less than $1 a visit on the average, and in some cases as low as 25 cents. The members paying monthly dues and not so much per visit run to this doctor on the most trivial excuse, thereby unduly multiplying the number of visits. Some of these lodge doctors see forty patients a day, receiving therefor from $100 to $150 a month. It is no wonder, then, that the medical work done is, as a rule, of the most perfunctory sort. This fact is appreciated by the members of the societies, for often when fearing severe illness they will forsake their lodge doctor and consult some physician in whom they have greater confidence, feeling instinctively that the lodge doctor's service is worth what they pay for it. The outrageously poor quality of medical service, more than the cutting of prices, is the ground for the medical profession's discountenancing lodge practice.

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Under workmen's compensation and compulsory industrial accident insurance, practically the whole of traumatic surgery is taken from the lodges; and if insurance against illness of workmen becomes a fact in this country, as it has in England and Germany, the *raison d'être* of most of these associations will have disappeared. England and Germany, however, instead of destroying these societies, have utilized those of them which are financially sound, and have in fact commisioned them to take care of accident and illness of members, but under strict governmental supervision.

Of late, in most of the large cities of America, people of small means have been exploited by lay organizers or promoters of so-called hospital associations. By cleverly worded advertisements promising first class medical and surgical service and hospital care often in a hospital chosen by the patient, memberships into the thousands have been built up. Since a large proportion of the dues collected is retained by the promoter as compensation for his labors in effecting the organization and for other reasons, the members of the medical profession of high standing and ideals are not attracted and the quality of medical and surgical service provided is necessarily poor. These so-called hospital societies or associations are considered by the better men in the medical profession as distinctly pernicious. Clinical records, if kept at all, are utterly inadequate. These hospital associations are at bottom little more than money-making schemes for the benefit of the promoters, and the laboring classes furnish a great majority of the victims.

Another evil foisted on the people of small means is the so-called Great American Fraud — the "patent medicine" evil. The victims are drawn mostly from the class of wage earners who buy the medicines not so much because of greater faith in such medicines than in the prescriptions of reputable physicians, but largely as a matter of the saving of doctors' bills. It

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is human nature to be more willing to pay for medicines which are things tangible than for professional advice.

Compulsory industrial accident insurance when properly administered will go far toward supplanting these organizations in the good they do. It will do it better and will be freer of harmful influence. If applied to sickness as well as accident, it will be a most potent check to the evils of "contract practice," "lodge practice," "hospital association practice," and the "patent medicine" evil, and will put a premium on better quality of medical and surgical practice.

THE CALIFORNIA LAW

The compulsory industrial accident insurance law of the state of California is known as the Workmen's Compensation, Insurance and Safety Act, passed in 1913 and effective Jan. 1, 1914, amended in 1915. The chief amendment of medical interest is in substituting for industrial accident the idea of injury in employment, whether accidental or not, and including industrial diseases.

It applies to all employees except in farm, ranch or dairy labor, domestic service and casual employment. It provides for an industrial accident commission of three who are charged with the enforcement of the law, and establishes a state compensation insurance fund administered by the commission. The proceedings of the commission are public records, and their hearings have the force of courts of law, but with a far less formal procedure. While their simplicity of procedure is scarcely to be approved by the lawyers, it is a boon to doctors who have suffered as witnesses from the law's delays and from hostile cross examination, from misunderstanding and misrepresentation.

The law requires full medical and surgical attention for injured wage earners for the first ninety days, and makes it obligatory on the insurance carrier to furnish such medical, surgical and hospital treatment, includ-

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ing nursing, medical and surgical supplies, crutches and apparatus, as may reasonably be required at the time of the injury and within ninety days thereafter, and longer at the option of the commission.

In most of the states the power of these commissions is very great, there being no appeal from their decisions except to the state supreme courts, and this is time consuming and expensive and hence not often worth while. Under such circumstances it is all important that the commissions should be constituted of broad minded men of unimpeachable integrity: men strong enough to be just in the face of criticism and free from political control.

California has been fortunate in the personnel of its first commission, which has been in office long enough to have established precedents which will be difficult later to neutralize. Its attitude toward the medical profession is that of high appreciation, as is attested by its selection for medical director of a prominent physician who has the confidence and respect of the entire profession.

The following paragraphs from reports of the California Industrial Accident Commission, for the fiscal year ending June 30, 1915, indicate the excellent relations of the commission and the physicians of the state, and it is interesting to note the appreciation on the part of the commission of the possibilities as to the improvement in surgery that may be expected to result from the administration of the law.[1]

The commission has obtained the services of ninety physicians prominent in their several specialties, in different parts of the state. To these (medical referees) it looks for assistance in arriving at a just estimate of the medical aspect of cases. The interest manifested by these men is most gratifying. They are cooperating perfectly with the commission.

No small part of the success of the law is due to this cooperation.

The industrial commission is forming its standard of surgical results required of the medical profession of California, principally upon the opinions of the medical referees. These

1. Annual report, 1914-1915, p. 24.

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standards are very high. The effect will be better surgery through the state, diminished permanent disabilities, and decreased indemnities. Mediocre and careless surgical work can no longer pass in industrial accident cases. The commission is always at hand closely to scrutinize each case.

It has been found by bitter experience that all physicians qualified by the laws of the state to practice surgery are not necessarily surgeons.

The commission is gathering an x-ray museum, in which, from present indications, there will shortly be a complete series of examples of all bone injuries. This, with the mass of literature accompanying the cases involved, will eventually be of inestimable value for research, for treatment and for decisions of the commission. A medical library of reference and a museum of many interesting specimens procured from accident cases are in progress of development.

Through the state, the attitude of the medical profession toward the Workmen's Compensation Insurance and Safety Act, and the Industrial Accident Commission has shown a very noticeable and gratifying improvement. It may be said that understanding and cooperation are now universal. The profession realizes that while the act is doing good to the working people it also does good to the whole state. It realizes that the medical profession likewise shares in its benefits.

Of the many influences at work at the present time tending to improve the quality of surgical practice in this country, the most important and most fundamentally effective is, of course, the general betterment of medical education resulting from the development of medical schools on a university basis and under university control. Workmen's compensation and industrial insurance, however, is not to be despised in this regard. It must inevitably exert a powerful influence for better surgery over the whole country.

Already in California the insurance carriers are beginning to realize that it is poor economy to employ physicians and surgeons merely because they happen to be cheap. They are beginning to realize that true economy lies in the policy of employing such men as will insure a high quality of service. The poorly equipped and poorly prepared surgeon is in a fair way to being eliminated or, at least, to be relegated to the practice of surgery among the well-to-do who have to look out for themselves.

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Except through public opinion, which is a very lenient critic, slow of action, short of memory, and prone to be hoodwinked by the plausible, and through the hated malpractice suit, which, in a great majority of cases, is entirely pernicious, the work of the surgeon is seldom subject to review. Industrial accident insurance, by making it to the pecuniary interest of those responsible for the choice of a surgeon in accident cases to provide the best available surgical services, will furnish a practical incentive for following up the work of the surgeon and inquiring into the causes of poor results. The purse of the insurance carrier will be sensitive to a continued harvest of avoidable deformity and continued disability.

As a rule, the men who are doing good clinical work welcome such review and naturally those who do poor clinical work may be expected to resent it.

Moreover, it cannot be otherwise than that the industrial accident commission would be interested in learning from which men in a given community continues to emanate the larger stream of poor surgical results.

When it sends a case the rounds of the referees for determination of the nature of the original injury and the causes of the persistence of disability, the commission is apt to be impressed with the fact, too often evident, that the records of the earlier examinations are so imperfect as to make the determination of the original injury impossible. The medical director of the California commission is looking into the possibility of requiring records to be taken on prescribed forms. Through the state compensation fund, which the commission administers, the commission has it quite within its power to insist on such records being kept, and this will have a decidedly stimulating effect in favor of practitioners keeping intelligible records. Records to be intelligible must, of course, be based on careful examination of clinical phenomena. The commission has already practically insisted on roentgeno-

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grams being taken in the early stages of all cases presenting any suspicion of fracture or joint injury. It ought, likewise, to insist on a temperature chart being kept of all cases with inflammatory complications, as well as blood count and examination of the urine. The insurance carriers are so much impressed with the prevalence of syphilis that they have inaugurated a veritable boom in Wassermann reactions. They are eager to show that syphilis, if present, is to blame rather than the accident. The attitude of the commission is that if an accident has occurred in a syphilitic the case is compensable to the degree in which the syphilitic lesion is aggravated by the accident — or where syphilitic complications follow an injury and extend the period of disability very greatly beyond what would be normal with such person in the absence of such syphilitic condition, the case is not compensable for such extended disability. These points are not always easy of determination. Moreover, it is recognized that the Wassermann reaction is not infallible.

Diagnosis or mere expression of opinion unsupported by clear description of clinical findings on which diagnosis is based is not sufficient for the purposes of the commission, and the insurance carrier cannot afford to employ in important cases surgeons who do not keep reasonably clear records.

In the beginning of this movement of industrial accident insurance in this country, insurance adjusters anxious to make records of economy commonly employed men as surgeons on the basis of cheapness, instead of quality; and it would seem that the margin of profit must be pretty large in the great numbers of minor cases when one considers the heavy indemnities many of the companies have had to pay in consequence of poor surgical work in cases of severe injury. An encouraging sign in this direction is that a number of companies engaged in this sort of business in California have been forced to retire from the field partly

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because of the enthusiasm of their adjusters for cheap surgery. It thus happens that the industrial accident insurance fund in California is doing a larger business than any other insurance carrier, although the scale of premiums is the same. It is more liberal with the medical practitioners, and through its medical director it keeps sharp watch on the quality of surgical work done in its cases and makes quality the criterion of future employment. It is learning very rapidly which men in all parts of the state are doing the good work in these cases, and which are doing the poor work.

It is difficult to arrive at an accurate estimate of the amount of money paid the medical profession for services in industrial accident cases, but the commission estimates that in 1914 there were 62,211 industrial accidents in California necessitating medical treatment. Compensation was paid injured employees in the amount of $1,131,630, and for medical services (including hospital charges) $730,178. In other words, of the total money paid out by employers and insurance carriers on account of industrial accident, excluding expenses of administration, 60 per cent. was paid to the injured workmen and 40 per cent. for surgical and hospital services; but figures are not available permitting the separation of the surgical from the hospital charges.

The California commission, in cooperation with the insurance carriers, has established a fee bill for surgical services based on the average earning power of the employees but is confessedly a tentative arrangement. In general, it provides a fee of $1.50 for a visit at house or hospital, and 1 dollar for an office visit, with a scale for typical operations, varying from $5 to $75, assisting at operations from $5 to $10, administering a general anesthetic $5, and testimony before the commission as to fact of injury $10. Nothing is more difficult equitably to adjust than a professional fee bill under any circumstances, and such a fee bill

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based on a set fee for a visit is apt to be taken advantage of in unduly increasing the number of visits; yet, on the other hand, it conduces to insuring that the visits will be made and thereby possible neglect of the patient avoided. At times, however, it goes too far for decency, as in a case of fracture of the patella by direct violence with little displacement, in which the surgeon made two visits a day for weeks, and one visit a day for six months, his itemized bill reaching from ceiling to floor. In such cases and in case of dispute, all medical and hospital bills are passed on by the medical director of the accident commission, and finally by the commission itself. On the other hand, when an overenthusiastic insurance adjuster shows a tendency to browbeat a medical man into accepting a ridiculously small fee for competent work, the physician can have the matter reviewed by the medical director of the commission, who will see to it that an equitable adjustment is made; for example, the fee bill provides a fee of $10 for nonoperative first dressing of a fractured patella. In one case the adjuster tried to make a physician who had successfully performed a necessary open operation on a complicated comminuted fracture of the patella accept a fee of $15. The facts being made known, the medical director saw to it that the insurance carrier paid several times that fee, reckoning it as a major operation.

While the foregoing fee schedule is low, it was consciously adopted as a minimum schedule applicable to average cases. The commission has established the practice of approving bills for larger amounts for cases presenting features of unusual gravity or requiring unusual skill.

For example, the schedule fee for setting a fractured femur or humerus is $25. The commission has approved a bill for transplantation of bone for nonunion in the amount of $150 for the operation alone. For fractured tibia the fee of $10 is increased to $30 if operation of plating is done. The fee for operative

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refracture of bone for malunion has been approved at four times that provided in the schedule for the primary setting of the fracture.

The fear expressed by medical men when asked to accept this schedule, that if accepted it would be used in courts of law as a precedent and applied to cases in private practice, seems not to have materialized.

In most of the states the state industrial accident commission or board has no jurisdiction over the employees of corporations engaged in interstate commerce except in some states where, if the distinction between interstate and intrastate commerce can be clearly made out, the commission has jurisdiction over the employees of such corporations who are shown to have been engaged in intrastate commerce when injured. These corporations, nearly all large employers of labor, are keen to take advantage of this exemption for the reason that thereby they avoid paying compensation to injured or maimed employees. It is estimated (Pillsbury) that not more than 12 or 15 per cent. of employees of railroads engaged in interstate commerce come under the jurisdiction of the state industrial accident commission, and that at most only 25 per cent. receive compensation at all comparable to that received by all other workmen in the state, except in agriculture and domestic service, which are specifically exempted in the law. In other words, 75 per cent. of injured railroad employees receive no compensation for temporary or permanent disability beyond medical and hospital care. In case of accident to a railroad employee, it is often difficult to determine whether the man was at the time employed on interstate or intrastate commerce — his duties might change in this regard within an hour. In fact, in most cases it can be determined only by an actual trial with hearing of witnesses, etc.

Employees engaged in interstate commerce are under the federal law of 1907-1908 (extended by amendment), which is based on fault, and receive no com-

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pensation for disability except where negligence can be proved. On the other hand, railroads commonly continue the wages of their employees during temporary disability, and maintain a system of pensions for continuous service. They also exercise the opportunity afforded by the diversity of employments required by their business of placing maimed employees in position in which their deformities are not disabling.

These corporations, as a rule, maintain their own hospitals and corps of surgeons, in some instances making generous contribution to the funds contributed by the employees, and giving the employees a voice in the election of the surgical staff. The surgical service, however, is not subject to review, as is the case with workmen under state industrial accident insurance; but railway surgeons have the great advantage of being able to take their serious cases to central hospitals where efficient service may be given.

Osteopathy has not been recognized by the industrial accident commission of California except under certain circumstances. At the present time, the law of California provides for representation of osteopathy on the state board of medical examiners, but osteopathists are not permitted to perform major operations, or to give anesthetics.

The common law right of an injured employee to sue his employer in the civil courts is abrogated by the compensation law in most of the states except in case of the grossest negligence. This results practically in barring suits for damages; but the publicity given unfortunate results by the practice of the commission and the insurance carriers of sending the patient from one surgeon to another in the hope of finding some one who can remove the deformity and disability and thereby lessen the indemnity, entailing as it does necessarily criticism of the incompetent surgical work which may have been the cause of the failure to prevent deformity and disability, is very apt to engender

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malpractice suits. Again, the commission sometimes asks a surgeon witness whether if proper competent surgical attention had been given in the beginning of a case the disability might have been avoided. Occasionally this question must be answered in the affirmative, and record is made of the question and answer.

Thus far, I believe, only three suits for malpractice have occurred in industrial accident cases in California in the two years and a half since the law went into effect, and I am informed that all these cases are without merit and are not based on criticism of the attending surgeon made by medical referees or in the office of the commission. In fact, the commission in California deprecates malpractice suits and does all in its power to forestall them.

In event of suit, however, against a surgeon whose professional fee for service rendered in an industrial accident case paid by the insurance carrier, it is not to be expected that the insurance carrier will assume the defense of the surgeon except in the unusual case in which the surgeon has a contract with the insurance carrier covering the point; for the surgeon who is requested to take charge of a case surgically is otherwise an independent contractor.

A most important judicial decision in the matter of malpractice suits in industrial accident cases was made by the Washington Supreme Court (No. 12747) so recently as February last, in *Ross* vs. *Erickson Construction Company,* in which the adverse decision of the trial court was reversed and the case remanded with instructions to dismiss on the ground that the legislature in passing the industrial accident insurance law had removed the physician as well as the employer from the litigious class, provided that the physician is regularly licensed to practice, but this decision is based on the peculiar provision of the Washington statute by which industrial accident insurance is substituted for all other forms of redress in such cases. On the

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other hand, in recent decisions in Minnesota, Wisconsin and Kansas the court has held that the physician is liable for malpractice in cases under industrial accident insurance as in other cases.

The attitude of organized labor to industrial accident insurance is difficult to understand. In fact, it has not yet taken shape and been finally formulated. I am informed by men close to leaders of labor organizations that organized labor is not altogether pleased with the law of California. A fundamental objection is made that the law is in effect paternalistic, and there is nothing which labor leaders take greater exception to than government paternalism. They feel that the individual workman should have the choice of his physician and surgeon, as if the freedom of choice were a more precious possession than a well qualified surgeon. In final analysis this freedom of choice of surgeon is apt to take the form of a labor union electing its own surgeon who is employed on contract and paid so much per capita of the membership or on salary. In either event he is elected by the union and will therefore be chosen rather as a compliment to his political acumen than to his professional attainment.

It is the idea and practice of the lodge doctor over again, and in no real sense does it establish the principle of free choice of the individual.

On other grounds it is very doubtful if free choice of physician or surgeon on the part of the injured individual would be a wise thing to provide. The principle is in force in Switzerland, to be sure, but when tried in France it was found that through collusion or what not the cost of professional services unduly increased and the amount paid in indemnities trebled.

The industrial accident commission of California maintains a small but active force of safety engineers through which, and by other means, it has done much to lessen the number of accidents and notably the num-

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ber of deaths from accident. In 1915, there were more than 60,000 workmen injured and 533 killed in industrial accidents, a reduction in number of deaths of 22 per cent. of the number reported in 1914, because of better conditions of labor, safety appliances and safety methods. The largest percentage reduction was in transportation and public utilities, while in service (employees of men in the professions, in hotel service, restaurants, domestic servants, amusement employees, etc.), where, because of diversity of employments, safety appliances and methods cannot so readily be applied and which have not come under jurisdiction of the safety engineers, there has been a slight relative increase.

SURGICAL PROBLEMS

It is not possible to consider in the present paper any great number of surgical problems in relation to industrial accident insurance, but it may be worth while briefly to discuss a few presenting considerations that have seemed to us to be of particular interest.

One problem of general application and of great importance is the difficulty of securing the cooperation of the patient in the management of his case. So much fuss is made oftentimes over a comparatively trivial injury, the patient being sent from one referee to another for diagnosis, and presenting perhaps only subjective phenomena, and so many consultations being had, that the patient feels that he must have received a terrible injury and continues to nurse and protect his injured member. In the meanwhile, taking no exercise yet continuing to eat with his usual appetite, his colon becomes engorged and toxic absorption occurs and continues; his muscles degenerate and his joints stiffen. I have seen several men almost irretrievably ruined in this way. It is apparently not possible for the injured workman to be persuaded to return to work until his indemnity ceases. From his standpoint, he is not restored to health as long as there remains any remnant of soreness or pain, or any stiffness of joints or

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weakness of muscle, although it may be perfectly evident to the surgeon that work is the one thing which will cause his pains to subside and which will restore him to health and strength. His very idleness prevents his attention from being distracted from his injury. He can scarcely help exaggerating it and becoming neurasthenic. Furthermore, it is in fact a difficult thing to provide for a man light work during his later convalescence, for he often cannot get the work to do, and as a rule he is unwilling to do other work than that of his trade. He suffers in many ways from idleness, often taking to drink.

As a matter of fact, there has been a great increase in the number of cases of traumatic neurosis and hysteria following accident since the law went into effect, whatever the cause. I refer to cases presenting definite clinical phenomena, such as muscular weakness and atrophy, psychic paralysis, excessive sweating, tremor, disturbed reflexes, sensory disturbances, especially irregular areas of anesthesia, etc. In many cases the doctors are distinctly at fault for their manner of attending the patient; sometimes being too solicitous, at other times not sympathetic enough, and in general from failure of the average practitioner to recognize the signs of beginning neurasthenia and his inability to carry out appropriate treatment.

It is particularly difficult to eliminate malingerers from the category of the neurasthenics; it is sometimes impossible for, by virtue of playing his part long enough, the malingerer frequently becomes a neurasthenic in fact. However, the practice of sending doubtful cases the rounds of the referees for examination and report has had the effect of eliminating many malingerers — some neurologist or eye man or ear man is very likely to detect the fraud. Here again it is all important to have competent examination immediately following an accident, and proper record made.

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It is an uncomfortable and really unfair condition of industrial accident insurance as at present administered in America that the burden of proof in so many cases is on the doctor to show that the patient is well enough to return to work. It is much easier to prove that a man is ill than to prove that he is not ill.

The law gives the industrial accident commission power to require the injured man to submit to surgical operation if it is decided by competent medical examination that operation will restore the patient to productivity.

Such a provision in the law would seem to be necessary because experience has shown that many men would prefer to be paid compensation on the basis of their present disability (assumed to be permanent) by which they would receive a larger sum than the indemnity for temporary disability would amount to, figuring perhaps that they could pay for the operation later out of the proceeds. But it is a dangerous principle and should be availed of for the benefit of an insurance carrier only in very exceptional cases, and where it is perfectly clear that operation is neither dangerous nor doubtful of result. The California commission provides that in such cases the choice of the surgeon who is to operate must be approved by the commission.

Hernia, because of its great frequency, its proneness to occur during middle age, and popularly understood to be the result of strain, is nearly always attributed to some particular accident.

There is little or no evidence to prove that oblique inguinal hernia is ever produced by a single strain. In fact, the evidence is all to the effect that it is the result of a congenital weakness, most often with persistence of more or less of the processus vaginalis and in acquired hernia, that is, hernia which has occurred in the course of some laborious employment, the facts almost certainly are that the hernia is the result not of a single trauma but of the continual bombardment of

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the internal inguinal ring by the intra-abdominal pressure, forcing the omentum into an infundibular pouch of peritoneum and causing that pouch gradually to stretch or to slide out till it forms a veritable sac.

It is idle to leave the determination of the cause of the hernia in a given case to the findings at operation, unless operation is done almost immediately after the receipt of the injury; and this would result, as in the German procedure, in the elimination of practically all hernias from the category of the accidental unless at operation a hematoma were found. This restriction seems unduly severe, since most hernias are in fact unknown to their possessors till they are discovered a day or so after an unusual strain which caused pain in the groin. I have seen a case in which a workman claimed compensation for an inguinal hernia said to have occurred after a blow on the groin and in which examination showed a hernia on the other side as well, though it was unknown to the patient.

Since, however, it is to the interest of the industry to have the workman restored to productivity, and, as said above, hernia is due to repeated strain generally received in the course of labor, it is in some sense an obligation on the industry to repair the damage. By this decision some little injustice may be done to an individual employer for whom the employee has worked but a short time; but since few employers carry their own industrial accident insurance (practically none but very large corporations), this small injustice is widely distributed by the insurance carrier. It is fair, therefore, that the insurance carrier should provide operation in any case of acquired hernia discovered after some unusual or accidental strain. A preexisting closed sac may be suddenly opened by such a strain, causing pain followed by discovery of a protrusion, and is properly indemnifiable to the extent of the cost of the operation and the period of disability incident to convalescence.

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Manifestly, true congenital hernia cannot be proper cause for indemnity as an industrial accident, but cases occasionally arise in which all the evidence points to the protrusion having appeared immediately after some severe strain. I once operated in a case in which there was no claim for compensation and therefore no possible element of malingering, and the evidence of the hernia being acquired was complete, the protrusion following a severe strain and being accompanied by great pain and followed by considerable soreness. At operation we found the hernial sac continuous with the tunica vaginalis.

Moreover, the cost is not large — $50 for the surgical fee plus hospital expenses — and the results of the modern operation for hernia in competent hands are so good (upwards of 90 per cent. of permanent cures) that it would seem right that considerable pressure should be brought to bear on the patient to submit to operation.

In cases in which there is doubt as to the danger of the operation, however, the right given the commission by the law to force the patient to submit against his will should not be exercised. For example, application was recently made by an insurance carrier, to have a decrepit old man of 70 with advanced arteriosclerosis forced to undergo operation for a hernia discovered after a well established accident or be cut off from compensation. The hernia was small and readily held by a truss, and when so held was not disabling. Operaation would not be urged in such a case in private practice, and certainly should not be performed in an industrial accident case, except at the request of the patient.

As to the frequency of hernia indemnified as due to industrial accident, it is well to realize that it is less frequent than one would suppose *a priori*. Four hundred and thirty cases of hernia were considered compensable in California in 1914 out of a total of 62,000 industrial accidents.

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Chronic arthritis, especially of the spine — arthritis deformans, if you will — is a common cause of controversy. We do not know to what extent such chronic arthritis is due to trauma, but doubtless in many cases trauma is an important cause comparable with focal infection and intestinal absorption; but we do not know particularly whether chronic arthritis may be the result of a single trauma.

A man who is the subject of chronic arthritis of the type of arthritis deformans is so vulnerable, however, that comparatively slight injuries may be completely disabling. In fact, he is oftentimes so vulnerable that no one can afford to employ him and carry his own industrial accident insurance.

It is particularly in these cases that it is difficult to secure the cooperation of the patient in returning to work. One such man who, by some wrench, had broken off one or more osteophytes from the body of one of his vertebrae, after six months of idleness told me he would not take the risk of doing a stroke of work because he could not afford to jeopardize his spine, and it was not possible to make this man believe that work was the very best thing to keep his spine from becoming completely and permanently rigid.

With the Roentgen ray, especially after prolonged search and with lateral or oblique views, fractures of the spine are found in much greater number than formerly.

Undoubtedly, in many cases of fissured fracture or fracture of the vertebrae with little displacement, cases which were not possible of diagnosis until the advent of the Roentgen ray, there is persistent pain, and the patients develop symptoms of neurasthenia. I believe that if John Ericsson had had the Roentgen ray he would not have invented "railroad spine," which has been the basis of so much strenuous controversy in surgical circles and in courts of law.

The laws of the various states are not perfect; they are not even uniform. They will have to be modified

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in numerous particulars, and it behooves the medical profession to study into the question individually and in committee in order intelligently to influence legislation to the end that the real interests of the laboring people be served from the standpoint of quality of surgical service provided, and that no injustice be done the medical profession.

There are many practical questions to be decided, among others the adjustment of the relations of hospitals and dispensaries to the movement. By taking the great mass of laboring people out of the category of the recipients of charity, a great burden will be lifted from many struggling hospitals and dispensaries.

On the other hand, just as private cases often may be best worked out by groups of associated physicians, so these industrial accident cases and, when health insurance comes, cases of illness in the laboring classes may be economically and efficiently handled by dispensaries, of which the better clinics maintained by medical schools may be taken as the type. It would be greatly to the advantage of the patients to be utilized for teaching purposes, and practically few of them would seriously object, for it is widely known that in teaching hospitals and clinics the patients receive the most thorough study.

Endowed hospitals and dispensaries caring for industrial accident cases will derive a considerable income from them, and the disposition of funds so created may become matters of controversy. It would appear that the surplus of such funds should be devoted to the betterment of the hospital or dispensary service concerned, including payment of something in the way of salaries to the professional personnel.

Taking these cases out of the category of charity patients will tend to the creation of private dispensaries and even hospitals, as has occurred in California. There is no fundamental objection to hospitals and dispensaries being established for the purpose of caring for these cases if they are under the supervision and

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regulation of the accident or health commission in such wise as to guarantee a high quality of professional service.

CONCLUSION

I would repeat that social insurance against industrial accident constitutes a great world movement. Already in force in thirty-one states in America, it is sure to be adopted in the remaining seventeen and to be followed by insurance of the working classes against illness. The idea has come to stay and must be seriously reckoned with by the medical profession. If the medical profession accepts it in a proper spirit and accommodates itself to it, there is sure to result not only immeasurable good to the working classes, but also much good in the direction of improvement in the practice of surgery and in the practice of medicine as well.

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COMPLICATIONS AND SEQUELAE OF THE OPERATION FOR INGUINAL HERNIA

AN ANALYSIS OF ONE THOUSAND AND FIVE HUNDRED CASES AT THE MASSACHUSETTS GENERAL HOSPITAL

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The operation for the repair of inguinal hernia is rightly regarded as one of the most satisfactory and simple of surgical procedures. The operative technic has become practically standardized for the routine case, the general principles of closure of the canal being accepted with difference of opinion only as to the merits of transplantation, or nontransplantation, of the spermatic cord. Special and unusual cases, particularly large, direct hernias, may require special measures, such as transplantation of the rectus muscle, or sheath, or implantation of fascia lata.

Large series of cases have been reported by individual operators of great experience, showing a very high percentage of cures and a practically negligible death rate. Coley[1] reports 3,100 cases of inguinal hernia in which operation was performed at the Hospital for Ruptured and Crippled from 1891 to 1912, with twenty-eight recurrences, less than 1 per cent. of the total number. Out of 3,383 cases of hernia of all kinds in which operation was performed there were six deaths, a mortality of 0.17 per cent.

The statistics of Wölfler's clinic at Prague comprise 1,460 nonincarcerated inguinal hernias in which operation was performed between 1895 and 1910, with eight

1. Coley: Keen's Surgery, vi.

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deaths, a mortality of 0.63 per cent. Relapses after operation were estimated at from 5 to 8 per cent.

The dissemination of such favorable modern statistics as these, together with improvements in general anesthesia, the introduction of spinal anesthesia, and wide adoption of local anesthesia have greatly extended the field of this operation. An increasing number of the ruptured are insistently demanding surgical relief from the uncertainties and annoyances of truss treatment.

Patients who a few years ago would have been rejected as unfit surgical risks on account of age, infirmity or intercurrent disease are now readily accepted for this operation, until it is beginning to be a question if the pendulum is not already swinging too far. At any rate, it seems an opportune time to check up results, to audit, as Codman would express it, our hernia accounts.

The 1,500 cases which form the basis of this report were consecutive cases of inguinal hernia in which operation was performed at the Massachusetts General Hospital from October, 1908, to December, 1914. Definitely strangulated hernias are not included, but cases of incarceration without acute symptoms are counted.

In considering these statistics, it must be borne in mind that the operations were performed by a large number of surgeons of varying degrees of experience, no less than seventy-five individual operators. There were 1,093 operations done by members of the visiting staff, the largest number to the credit of any one operator being 117, and the smallest, 1; 663 operations were done by fifty-three different members of the junior house staff.

The patients also showed extreme variation as to age, physical condition and social condition, as would be expected in a large general metropolitan hospital. Comparison of such statistics with those of single oper-

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ators dealing with somewhat selected material cannot but be disadvantageous.

The youngest patient was 10 months of age, the oldest 77 years. There were ninety patients between 1 and 10 years of age. Eight patients were over 70. The largest number of cases fell in the decade between 20 and 30, namely, 397.

There were 1,388 males and 112 females. In 1,244 cases the hernia affected one side only; in 256 it was double. In eighty-eight cases the hernia was direct, in the others indirect. No cases of strangulated hernia were included. In ten cases the hernia was of enormous size. In sixty-nine cases the hernia was complicated by undescended testicle. There were nine cases in which the bladder was contained in the sac. In one of these cases there was a large stone in the bladder contained in the hernial sac. The appendix was found in the sac eight times, and removed in the course of the operations forty-six times. There were seven cases of sliding hernia. There was hydrocele present in forty cases, marked varicocele in twenty-six cases. In fifty cases there had been a previous operation for hernia, with recurrence.

In the 1,500 cases there was a total of 1,756 operations, counting double hernia as two operations. In the male cases the Bassini technic was employed 834 times, Ferguson 764, and Halstead fifteen, with twenty-four cases of varying and miscellaneous technic.

In sixteen cases in which the hernia was complicated by ectopic testicle, orchidectomy was performed. In fifty cases the undescended testicle was brought down into the scrotum; in one case it was dropped back into the peritoneal cavity. In nine cases orchidectomy was done in the course of the operation on account of tuberculosis, gumma or other lesion of the testicle.

In many cases operations for other conditions, such as gallstones, ventral hernia, stricture of urethra, etc., were done at the same sitting.

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The anesthesia was general in 1,319 cases. Spinal anesthesia was used in eighty-nine cases. Spinal anesthesia was supplemented by general in nine cases, and local in six cases. Local anesthesia was used alone in seventy-five cases. There was one case of rectal anesthesia, and one case in which the anesthetic was not stated.

Accidents of operation were reported as follows: Injury to the bladder in two cases, with immediate suture, without ill effect. The vas deferens was reported cut seven times; in one case end-to-end suture was attempted. In two cases a small nick was made in the bowel and immediately sutured without bad result. There were no cases of injury to the iliac vein.

There were eight deaths in this series, a mortality of 0.53 per cent. In two of these fatal cases there were complicating conditions present which were largely responsible for the result. One case was that of a man of 63 with diabetes mellitus, having a scrotal hernia and symptoms of severe cystitis. Under spinal anesthesia a suprapubic cystotomy was done; it was then found that there was a hernia of the bladder through the inguinal canal. As the bladder could not be withdrawn through the hernial opening, the inguinal canal was opened and a stone was found in the portion of the bladder lying in the hernial sac. The stone was removed, the inguinal canal repaired and bladder closed about a suprapubic drain. The patient died of sepsis. This unusual case might, I think, fairly be left out of hernia statistics.

In the other complicated case a ventral hernia was repaired at the same sitting; general peritonitis developed, with fatal result. Necropsy showed that the peritonitis developed from sepsis in the ventral hernia wound. In this case it is manifestly unfair to burden the inguinal hernia operation with the fatal result. This leaves six cases of straight hernia with fatal issue. In three cases death occurred suddenly, and unexpectedly,

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on the fifth, thirteenth and fourteenth days, respectively, and was ascribed clinically to pulmonary embolism. There were no necropsies.

In one case the patient, a feeble man of 69, with double hernia, gradually petered out and died comatose on the tenth day.

In another case of double hernia a large hematoma developed which was subsequently drained. A secondary operation was performed on the eighth day on account of abdominal pain, distention and vomiting, with high temperature. Perforated ulcers of the colon were found, with general peritonitis. Necropsy showed no direct connection between the hernia operation and the peritonitis, which was evidently the result of perforation of ulcers of the colon.

In the last case death resulted on the eighth day, with symptoms of vomiting, distention and jaundice. Necropsy showed focal pneumonia, and extensive hemorrhage into the mesentery and retroperitoneal tissues.

Nonfatal postoperative complications of more or less severity developed in 438 cases, or 28 per cent.; some of these were trivial. In many cases the complications were multiple.

COMPLICATIONS

Sepsis.—In 158 cases the wounds failed to heal by first intention. In ninety-three cases the sepsis was trivial, consisting either of a stitch abscess, or more often a collection of serum which required draining. In many of the latter cases probably no infection was present; cultures were not made. In sixty-five cases there was frank pus in the wound, under 4 per cent. of the total number of wounds.

Of the seventy-five cases in which operation was performed with local anesthesia, sepsis developed in the wounds in thirteen cases, or 17 per cent.

Of the eighty-nine cases in which operation was performed with spinal anesthesia, there were nine septic wounds, or 10 per cent.

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Hematoma.—In 112 cases the development of a hematoma was mentioned in the record; in twenty-seven of these cases it was stated to be slight. Marked and extensive ecchymosis was noted in two cases; in one of these it extended to the chest wall. In both cases it subsided spontaneously.

Subsequent orchidectomy became necessary in five cases, once on account of tuberculosis, and once on account of sloughing of a transplanted undescended testicle.

Complications in the Respiratory Tract.—These were of common occurrence, namely, 138 cases (9.2 per cent.) distributed as follows: Frank pneumonia was reported in seven cases, questionable pneumonia in one. Bronchitis was recorded in forty-eight cases; postoperative cough, with slight temperature, in forty-three; pulmonary infarct, two; pleurisy, one; colds, six, and tonsillitis, thirty.

Respiratory complications were by no means abolished by the use of spinal or local anesthesia; this probably was partly due to the fact that these forms of anesthesia were selected on account of chronic bronchitis or cough on the part of the patient. At any rate, respiratory complications occurred in twenty-five of the 170 in which spinal or local, or a combination of the two were used, nearly 15 per cent. Of these, one case of pneumonia and one fatal case of pulmonary embolism followed spinal, and one nonfatal pulmonary infarct local, anesthesia.

Miscellaneous.—There were many miscellaneous complications distributed as follows: otitis media, two; measles, one; cholangeitis, one; persistent hiccup, three; phlebitis, three; acidosis, two; pyelitis, one; ataxic paraplegia, one (this was not a case of spinal anesthesia). There were three cases with marked postoperative mental symptoms; one with delirium, and two with hallucinations and attempted suicide. The latter were both cases of spinal anesthesia.

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END-RESULTS AND RECURRENCE

End-results were obtained through the routine follow up system of the hospital, no special effort being made to trace cases for this report. The hospital system consists of sending a letter to each patient, one year from date of discharge, requesting return to the hospital for examination; if this is impossible, report of condition by letter is requested.

As already stated, eight patients died in the hospital after operation. Data subsequent to discharge were obtained in 754 cases, just over 50 per cent., in which 140 patients reported by letter and 614 reported in person for physical examination. Eleven patients died of intercurrent disease during the year; 577 were reported unequivocally well, or cured, 38 per cent. of the total number operated on, and 76 per cent. of those whose subsequent histories are known. Ninety-nine patients are classed as relieved; fifty of these were cured of the hernia but complained of subjective symptoms more or less closely associated with the wound. The commonest complaint was of pain in the wound, especially when working or lifting. Two complained of persistent numbness in the inguinal region. Of the others in the relieved class, seventeen patients had no actual recurrence of hernia but a bulge in the region of the scar; eight had marked varicocele; five were cured of the hernia for which they were operated on, but subsequently developed hernia elsewhere; three had atrophy of the testicle; two had keloid in scar; one had a persistent sinus; one developed adenocarcinoma of the sigmoid, and one was cured of hernia but had incontinence of urine. There were six cases of miscellaneous and unclassifiable complaints.

Fifty-nine patients had definite recurrence within the year; five of these had double recurrences; two are known to have recurred after the lapse of a year, making a total of sixty-six recurrences, or 3.7 per cent. of the total number of operations performed, and 8 +

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per cent. of the number of cases traced. There were six cases in which there was questionable recurrence. In two of these, relapse was claimed by the patient but could not be found by the examiner. If these six cases are counted as recurrences, the percentage is raised to 9 per cent. of the cases traced.

Of these recurrences, twenty-six, or 3.1 per cent., followed the Bassini operation, and thirty-four, or 4.4 per cent., the Ferguson.

In the sixty-seven cases of recurrence or questionable recurrence, postoperative sequelae were distributed as follows: cough, eleven cases; hematoma, nine, and sepsis, four.

In the 112 female cases there were only two recurrences.

Of the eighty-eight direct hernias there were recurrences noted in seven, or 7.9 per cent., or 15 per cent. of the direct hernia cases traced.

There were only two relapses out of seventy-five cases in which operation was performed with local anesthesia, 2.5 per cent. of recurrences; but it must be borne in mind that these were for the most part the less severe types of cases.

Simmons found in his study of hernia that recurrence practically always takes place within six months after operation. This is undoubtedly true for the great majority of cases, but like all generalizations is subject to exceptions. In two of our cases counted among the recurrences, the patients were reported well at the end of the first year. Others which we do not know about may also have relapsed since the expiration of the year.

SUMMARY AND CONCLUSIONS

In summing up this statistical study of inguinal hernia, I desire to emphasize the following points:

The results of operation are on the whole good, better than might be expected under the conditions. The operation, however, has a definite, though low, mor-

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tality rate, and should not be undertaken in the old and the infirm without good reason.

Postoperative cough, hematoma and sepsis are important factors in the incidence of recurrence, but the latter complication seems to play a lesser rôle than is generally assigned to it.

A strikingly large number of patients anatomically cured complain of pain, probably due to nerve traumatism.

General anesthesia is still best in the routine case. Local anesthesia is very satisfactory, and has a wide application in cases in which inhalation anesthesia is contraindicated, but carries a slightly greater risk of sepsis, and hence probably of recurrence too, although the latter conclusion is not borne out by our figures. Spinal anesthesia, on account of its greater danger and serious sequelae, should have little place in this operation.

Careful study of the results in this series of cases reaffirms the importance of the well recognized surgical principles of clean anatomic dissection, conservation of nerve supply, high closure of sac, securely accurate coaptation of tissues without constriction, and complete hemostasis, in the attainment of success in the operation for inguinal hernia.

ABSTRACT OF DISCUSSION

Dr. Henry O. Marcy, Boston: Tracing the development of the male during the late fetal period we note the extrusion of the testicle from the abdomen and the carrying with it of the peritoneal covering investing the vessels and vas deferens, making up the spermatic cord. Normally, the peritoneum is so closed in about the structures at the exit from the abdomen that only by pulling on the cord do we note the slight depression on the peritoneal surface, which lines the abdomen at this point. When the opening through the abdominal wall is imperfectly closed there results a more or less marked depression of the peritoneum described by Cloquet as normal anatomy and called by him the "infundibular process of the peritoneum." This defective closure of the internal ring is the usual cause of indirect hernia, although it may not occur until an advanced age. When normally developed the intra-abdominal pressure is at right angles to the canal and firmly

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closes it. The reconstruction of the canal to its normal size and obliquity is the sine qua non in the cure of hernia. In 1870 I operated on a large strangulated hernia and closed the wound with buried catgut sutures. The cure remained permanent. My first publication for the cure of hernia was in November, 1870. I instituted a long series of studies on animals to determine the rôle of buried animal sutures and published many articles on their advantages. I early emphasized the reconstruction of the inguinal canal, to its normal size and obliquely as safe, easy and permanent. The cure of hernia was established on a firm basis. In 1882 I first obtained tendons from the tail of the kangaroo and introduced their use as a suture material in every way superior to catgut. Corroboration of the principles and practice which I have so long advocated is now ample. All aseptic wounds closed with buried aseptic tendon sutures will remain aseptic and in well vitalized structures will be followed by primary union. The aseptic absorbable animal suture, preferably tendon, I consider my best contribution to surgery and the cure of hernia is dependent on their wise use. For a long period it has been a far too common custom to accredit to European writers much that belongs to our profession. To Bassini, honor is due for his excellent work, but in method, experience and publication he is antedated by a number of American surgeons. At last the cure of hernia should be called the "American method." With all the emphasis of an earnest conviction, I commend to every aseptic surgeon familiarization with the methods of wound closure by means of buried absorbable sutures, and not alone predict their early general adoption but that, in importance, they have the first place in the technic of modern aseptic wound treatment.

Dr. Daniel Nathan Eisendrath, Chicago: Hernias in hospitals are generally operated on by the house men and careful supervision is not given to a series of operations by one operator. I was very much struck with one point made: that was the frequency of sepsis in cases with local anesthesia. I have had that experience in my early cases, but since I have diluted the epinephrin I have not had experiences of that kind. I think we use epinephrin as a local anesthesia too strong and we have a reduction in the vitality of the tissues which favors intervention. Instead of using 4 or 5 drops of a 1:1,000 solution to the ounce I seldom use more than 1 drop. A second point to which I wish to call attention is some of the causes of recurrences. I think we are very apt to forget that there are in a large number of hernias a series of diverticular sacs. I mean the sacs which come out from the internal ring and form a double sac, i. e., a short trouser leg and a long trouser leg. Many of us were formerly satisfied with dissecting up and ligating the neck of the sac. We think we are ligating high up. When-

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ever I find one having on the outer aspect a great deal of fat I put my finger in and see if there is a diverticulum, i. e., a pantaloon sac. Another cause is the comparative frequency of the concomitant occurrence of the direct and indirect hernia on the same side, parallel with each other and we are apt to overlook either the direct and the indirect. The next point is one Dr. Davis calls attention to, viz., the frequency of pain following hernia operations, and I have learned to be careful not to include any nerve fibers in my sutures. At the Michael Reese Hospital in Chicago, we uniformly do the Andrews operation of imbrication. It is the ideal operation in the type of cases of which we see so many, those with the very weak conjoined tendons. Our best result is in transplanting the cord invariably. I have not made an exception except in cases of undescended testes. The reason why this Andrews operation with the transplant of the cord is the ideal operation is that if you do not transplant the cord you have at the lower end a space that represents the pubic bone. You must make allowance for hard bony material with suture material. If you do transplant the cord you can work the many muscle tissues. I think that is the reason why a great many of these cases have recurrences, for the 34 per cent. of the total number of recurrences following the Ferguson operation.

Dr. Edward W. Lee, New York: To what extent, if any, does Dr. Davis consider that traumatic hernias exist? Is there such a thing as traumatic hernia? Is there not a condition that predisposes to hernia that would let hernia be produced? I ask this question because in connection with a former paper the workman's compensation law and medico-legal cases this question is becoming one that somebody has got to decide very definitely to determine whether we actually have what may be called traumatic hernia.

Dr. Lincoln Davis, Boston: In regard to the question just asked: I do not know. I have no data on traumatic hernia. It is my belief that there is a predisposing factor present in all these cases, probably a pouch in the peritoneum which enables the bowel to come through suddenly, but I really have not gone into that question. I agree entirely with what Dr. Eisendrath said in regard to the double sac. I think that is a very important matter, and I have frequently found a direct hernia accompanying indirect and I think it is the direct hernia which is the problem to cure. Particularly in those direct hernias, I think Dr. Andrews' operation of imbrication and overlapping the layers is of great value. As to sepsis in local anesthesia, I think our figures are altogether too high and we have perhaps been a little slow in taking up local anesthesia. I think we are going to use it more and more. I am a little bit in doubt myself as to whether you can do quite as secure a closure under local as under general anes-

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thesia. I think the infiltration of the tissues around the neck of the sac interferes with the most accurate and firm closure of the sac. We have not followed enough cases that have been done under local anesthesia to be convinced on that point. Dr. Marcy showed how the obliquity of the canal is one factor in preventing hernia and that is the condition that you wish to restore and it is for that reason that the direct hernia is so much more of a problem than the indirect. I found in these statistics which I have given you, that there was very little difference in the percentage of recurrence between the so-called Bassini and Ferguson operations. It was a little less than 1 per cent., I believe.

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THE SURGICAL PROBLEM OF UNILATERAL SYMPTOMLESS HEMATURIA

ITS CAUSES AND SURGICAL RELIEF

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Nearly every surgeon is occasionally confronted with a case of symptomless, unilateral bleeding from the kidney, and in most instances he must face the difficult problem of solving the pathologic problem if possible and then directing his treatment accordingly.

The first purpose of this paper is to exclude those specific causes of unilateral hematuria, namely, stone, tuberculosis, new growths and hydronephrosis, and secondly to discuss only that type which has in the past been classified under the misnomer of "essential." In order that this term "essential" shall be aptly applied we must have a case of painless bleeding in which the kidneys shows absolutely no infectious agent, no organic changes and no clinical evidence of functional insufficiency. We do not recognize that such a negative condition can exist with a hematuria, and believe that in every case of unilateral renal bleeding there occur definite changes in the kidney which act as the direct causative factor.

The etiology of the so-called essential hematuria has been discussed at length in many valuable articles appearing during the last five years, but it is the purpose of this paper to consider only our findings in the human and experimental cases we have personally studied.

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In considering the many theories and deductions so far advanced as to the cause of this condition, one is forced to conclude from the evidence in hand that there is only one of material value, and this is nephritis. There is little room to doubt that the bulk of the pathologic evidence is in favor of some form of chronic inflammatory change in the kidney acting as the exciting factor in symptomless, painless and more or less continuous unilateral hematuria.

The great drawback to this evidence being accepted as conclusive is the wide variance in the pathologic observations so far recorded, and the chief obstacle seems to lie in our interpretation of what is nephritis. Recent experimental work would not exclude a combined vascular and epithelial nephropathy, but changes in the kidney resulting in hemorrhage as the one symptom must necessarily be confined principally to the vascular elements. In order to prove that certain chronic inflammatory changes in the kidney are the cause of this bleeding, we must first demonstrate a direct relationship of these changes to the renal vessels, and then show these vessels to be the actual source of the bleeding.

There has been but one type of lesion so far reported which would seem to us to be the probable cause of bleeding in this condition, and that is the renal varix reported by Fenwick,[1] Cabot,[2] Braasch,[3] Newman,[4] Pilcher,[5] Baum,[6] Payne[7] and Ballenger.[8]

Our studies are confined to eleven human and six cases of experimental hematuria which we have succeeded in producing on the dog. In the first eight human cases our findings seemed to coincide with those

1. Fenwick: Brit. Med. Jour., June 17, 1905.
2. Cabot: Am. Jour. Med. Sc., January, 1909.
3. Braasch, W. F.: Clinical Observations on Essential Hematuria, The Journal A. M. A., Sept. 20, 1913, p. 936.
4. Newman: Brit. Jour. Surg., No. 1, 1913.
5. Pilcher: Ann. Surg., 1909, p. 65.
6. Baum: München. med. Wchnschr., 1913, No. 5.
7. Payne: Tr. Southern Surg. and Gynec. Assn., 1915.
8. Ballenger: Jour. Rec. Med., Atlanta, 1915.

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of other investigators, namely, nephritis, interstitial nephritis and glomerulonephritis. It is to be recorded, however, that nephrotomy was done in these cases and sections of the cortex only were studied. Fifteen months ago we did our first nephrectomy for this condition, and in this case we were able to demonstrate for the first time the actual source of the bleeding to be from dilated veins in the pyramids and on the free surface of the papillae. Since this first case we have had two more human cases which showed the same pathologic changes, namely, few if any changes in the cortex, a marked overgrowth of chronic inflammatory tissue in the medulla and pyramids which surrounded the vessels of this zone, and these vessels in turn dilated and resembled varicosities. In those cases of experimental nephropathy in the dog in which we have succeeded in securing a condition of hemorrhage analogous to the clinical type under study, the same changes in the kidney have obtained.

In our experimental study of hematuria we have learned to recognize two distinct types resulting from infection: first, the early form of bleeding from acute inflammation with diapedesis, and second, a cessation of this hemorrhage with return of more or less constant bleeding when chronic inflammatory changes occurred in certain definite areas of the kidney. In any chronic progressive infectious process, sooner or later there results a secondary damage to the tubules and a replacement fibrosis. The effect of this fibrosis on the circulation in the kidney depends on its relationship to the renal vessels. Certainly in two human cases of symptomless unilateral hematuria which we have studied, this overgrowth of connective tissue in the papillae and at the corticomedullary junction had resulted in such impediment to the return venous flow from within the kidney that varicosities had been produced, both within the substance of the medulla and on the free surface of the papillae, and actual hemorrhage from these vessels was demonstrated.

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We do not want to draw from these studies any dogmatic conclusions; but we can say definitely from our observations in the human and experimental kidneys examined by us that the hemorrhage is due to chronic inflammatory changes in the medulla and pyramids resulting in an obstruction to the venous return and subsequent hemorrhage by diapedesis or actual rupture of the capillaries. Of special importance in this connection, our studies show the formation of connective tissue at the corticomedullary junction which hinders the return venous flow from those veins found in the medulla below this point, the venulae rectae, which pass up to the corticomedullary junction to unite with other veins before finally leaving the kidney.

In this connection we wish to record three cases, one human and two experimental in the dog, that we have observed to have microscopic stone formations in the pyramids surrounded by an overgrowth of chronic inflammatory tissue which obstructed the return flow in the straight veins with coincident hemorrhage. A possible explanation of the relationship between this type of calculus formation and the hemorrhage is that the stones resulted from a chronic focal infection and they in turn stimulated the connective tissue overgrowth. We are not in a position to say that all cases of so-called symptomless hematuria are due to the changes here described, but report our observations as additional light on the unsolved pathologic problem.

The one great argument brought forth by many observers against nephritis being the cause of this condition is the comparatively large number of chronic nephropathies which do not bleed. In reply to this well taken point we would say that in the ordinary severe types of chronic nephritis the bulk of the changes are in the cortex, whereas the changes here recorded are found in the medulla and pyramids. Further, in our studies of experimental nephropathies we have so far found a bleeding kidney only

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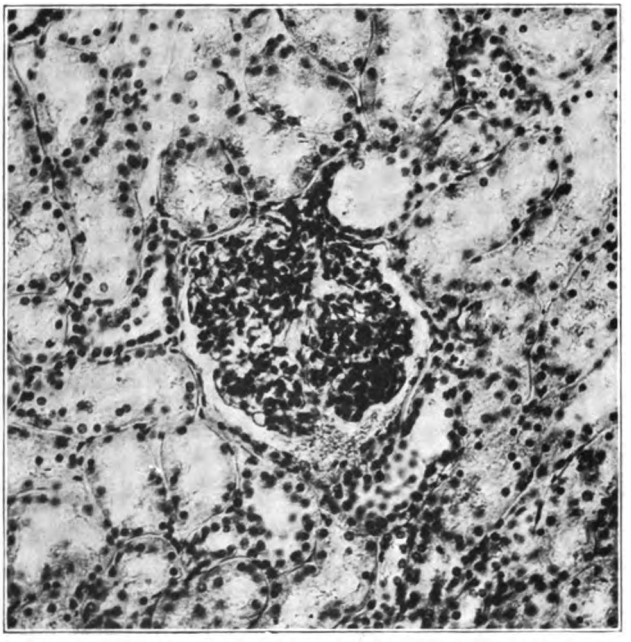

Fig. 1.—Normal cortex, × 390, in same tissue section from which the following pictures were made.

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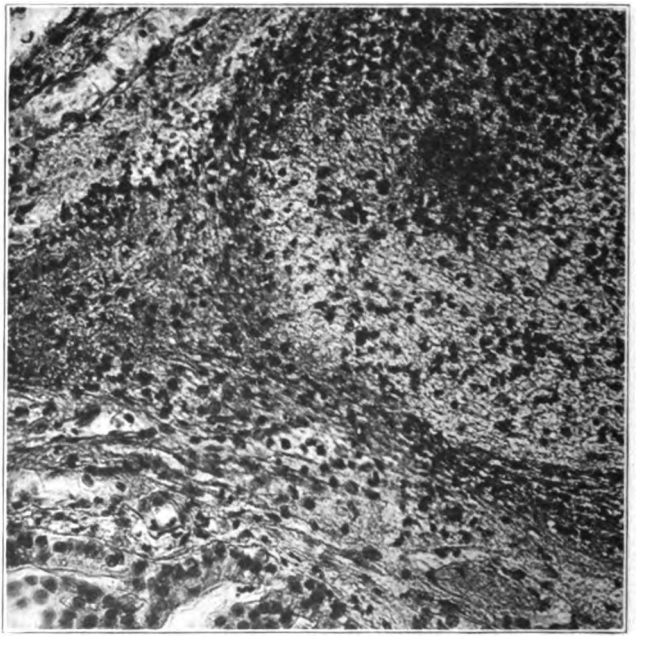

Fig. 2.—Area of recent infection in papilla, × 188. Exudate consists of fibrin, blood cells and polymorphonuclear leukocytes.

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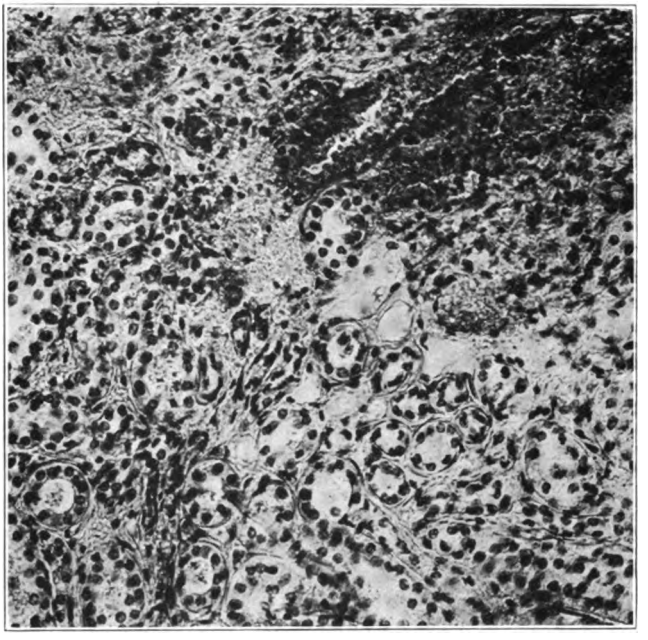

Fig. 3.—Overgrowth of connective tissue in medulla with distention of capillaries, × 190.

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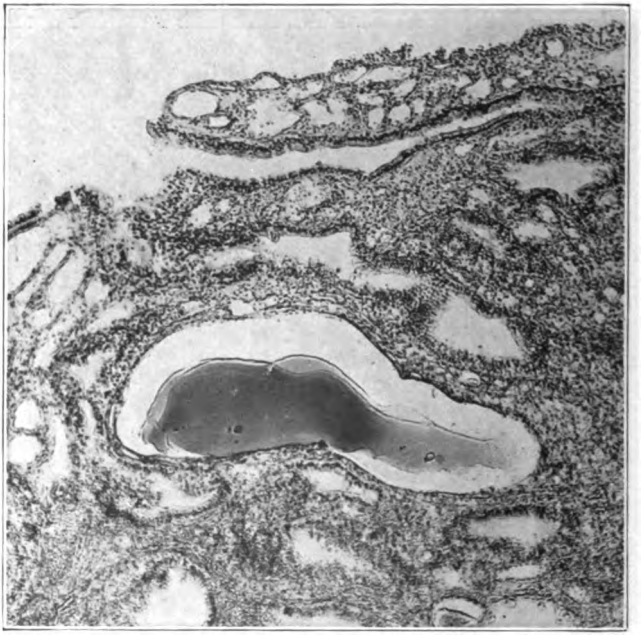

Fig. 4.—Dilated venules at tip of papilla, × 45. In some, the blood has not coagulated; in others, clotting has occurred, and hyaline degeneration of the thrombus is beginning; in others, the hyaline change is complete, while some show beginning organization.

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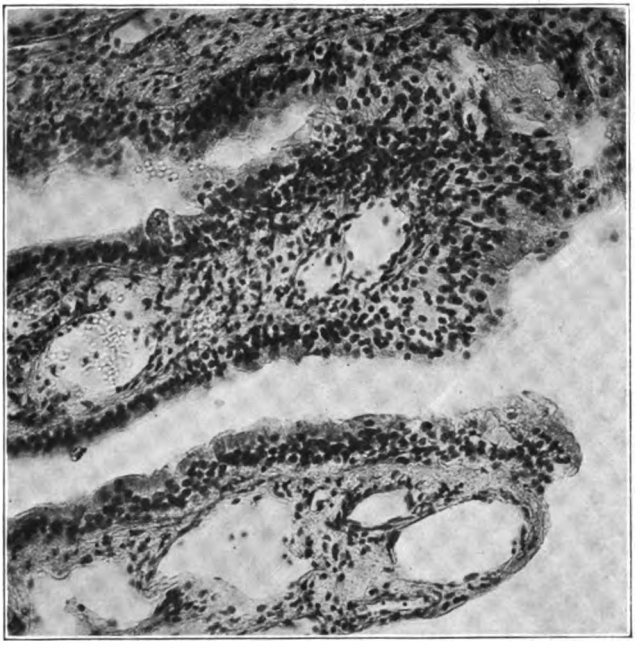

Fig. 5.—Greater portion of papilla, × 116. Here is shown the opening of a duct of Bellini and numerous distended venules; some venules show no blood; others have noncoagulated blood, and yet others show thrombi undergoing hyaline degeneration.

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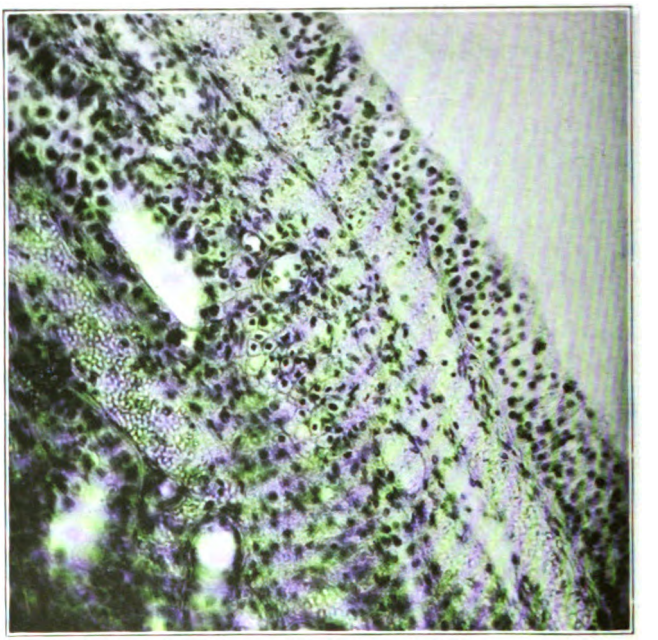

Fig. 6.—One long dilated venule just under the epithelium covering the papilla, × 300.

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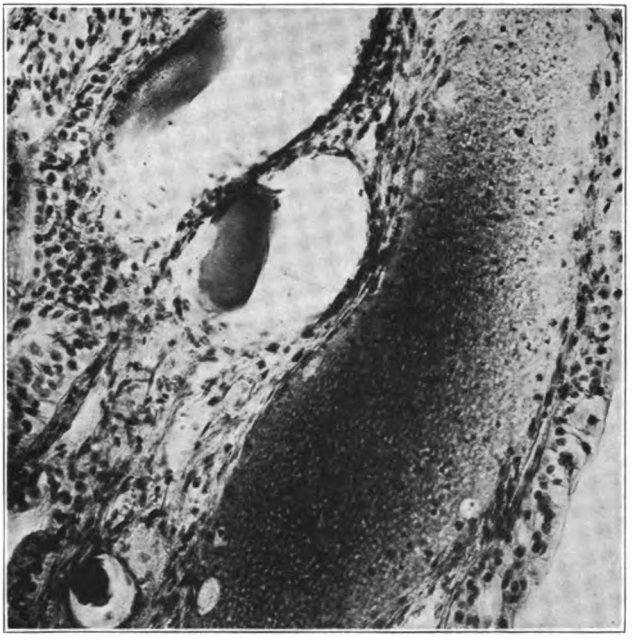

Fig. 7.—Thrombosis of large vein just under the surface epithelium covering the papilla. Red blood cells are shown in the center, while the edges of the thrombus are beginning to undergo hyaline degeneration.

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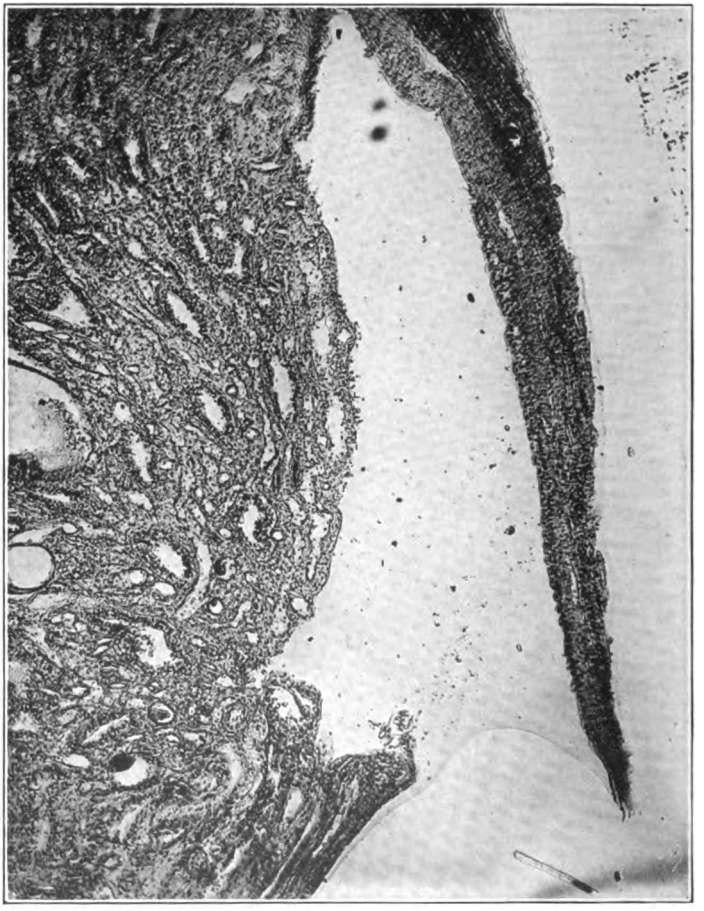

Fig. 8.—Large vein which has ruptured on the free surface of the papilla and discharged its contents (× 45).

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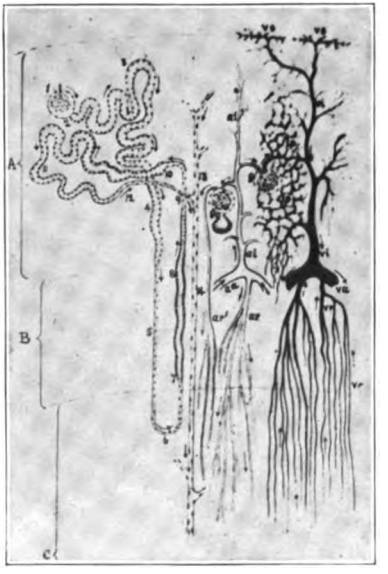

Fig. 9.—Diagram of renal vessels (from Beattie and Dickson): *A*, cortex; *B*, midzone (corticomedullary junction); *C*, medulla. Areas *B* and *C* represent points at which the connective tissue causes obstruction to the straight veins.

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in those cases in which the principal changes have occurred in the medulla and pyramids. In this connection it would be interesting to know what those cases observed by other men would show if viewed from this light and careful studies made of serial sections taken from the pelvic zone. Certainly small sections from the cortex would show nothing convincing, as evidenced by the eighty-odd histologic reports found in literature.

The contentions of Randall[9] and Spitzer[10] that congestion or venous stasis is the true cause of this condition more or less coincides with our findings, only these observers failed to locate the exciting factor as a focal lesion within the kidney proper. It is a fact that certain extrinsic causes, such as movable kidney, pressure stasis from tumors, and cardiac and hepatic lesions, will cause hematuria, but these are specific causes which do not obtain in the type of case under study. Again, congestion from extrinsic causes will usually produce a mild hematuria, while most of those so-called essential cases bleed profusely at times.

TREATMENT

Nephropexy.—This has been advocated, but one can readily see how futile this would be in the type of case in which definite focal lesions in the kidney are producing the hemorrhage. It should be applied only in those cases in which marked mobility can be shown to interfere with the blood supply of the kidney.

Decapsulation.—This is a procedure which has been reported as curative in seventeen cases found in literature; but the rationale of the operation is not such as would commend it for routine use. A collateral circulation would be the most reasonable explanation for a cure after decapsulation, but according to the conclusive experiments of Katzenstein,[11] stripping of

9. Randall, Alexander: The Etiology of Unilateral Renal Hematuria, The Journal A. M. A., Jan. 4, 1913, p. 10.
10. Spitzer, W. M.: Continuous Painless Renal Hemorrhage and Its Treatment, The Journal A. M. A., Dec. 12, 1914, p. 2110.
11. Katzenstein: Ztschr. f. exper. Path. u. Therap., 1911, ix.

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the capsule absolutely prevents rather than favors the formation of a new circulation. The question of a new growth or a small tuberculous focus is always a serious possibility in these cases, and decapsulation without nephrotomy does not provide for inspection of the kidney substance or pelvis. We had one such case seven years ago, diagnosed essential hematuria, which showed a small focus of tuberculosis in the lower pole when nephrotomy was done. Similar reports have come from Israel, Rovsing and others, and it is just these serious possibilities in this unsolved pathologic problem which should preclude decapsulation alone as a safe surgical procedure. On the other hand, there are several cases reported in which decapsulation failed to cure and nephrectomy was later done.

Nephrotomy.—The one procedure which has yielded the best results is nephrotomy with bisection from pole to pole and down to the pelvis; but we find nine cases reported in which this method failed to cure. We have had eight cases treated by nephrotomy with suture in which cure followed in every instance. Some of the failures accredited to this procedure may be due to the insufficient method of performing the nephrotomy. We know of two such instances in which the operator explored the kidney and pelvis through an opening just large enough to introduce one finger. Certainly in many of these cases the condition is essentially an infectious process, and this may explain why nephrotomy in some instances has failed to produce a cure. Since nephrotomy does not remove the infection, we may expect a temporary cure in a small percentage of cases, for it is possible that the same sequence of pathologic events as described above may recur, which would result in a return of the hemorrhage and finally demand nephrectomy for an ultimate cure. There are also numerous cases of nephrotomy reported in which nephrectomy was done within the

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succeeding forty-eight hours because of severe post-operative hemorrhage. Since we have had no such experience, we believe this complication is probably due to the technical fault of improper coaptation with mattress sutures. The method of complete bisection probably cures through thrombosis or the establishment of a collateral circulation within the kidney, which relieves the distention of the varicosities.

Nephrectomy.—This is a certain method of cure, but too radical to commend itself as a routine procedure. We have removed the kidney in two cases in which the exigency of the occasion demanded it. One showed such large and numerous varicosities, a condition unlike anything observed by us before, that nephrectomy was deemed wise. In the other case both main renal veins were accidentally lacerated, and we were afraid to leave the kidney in situ. This fear was emphasized by the belief from our human and experimental cases that the clinical condition is primarily one of focal venous stasis within the kidney. In cases in which the bleeding has produced a critical condition of the patient, and in those cases in which nephrotomy has failed to relieve, nephrectomy is clearly indicated, provided the other kidney is present and its functional capacity good.

Nonoperative Treatment.—This consists of styptic injections into the kidney pelvis and the hypodermic administration of vaccines, horse serum, human serum and whole blood into the circulation. The conservative treatment of these cases, however, demands serious consideration, for one can never know, until a case is proved cured, but what a new growth, a tuberculous focus or an undetected stone may be the exciting cause of the one symptom hemorrhage. In acute or subacute cases in which an infectious agent can be isolated, it is well to try vaccines. Given a case of mild unilateral renal hemorrhage without pus, a negative roentgenogram, a normal pyelogram and little or

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no functional impairment, which can be kept under constant observation, we believe that it should be treated conservatively by epinephrin to the kidney pelvis and serums hypodermically. Where the bleeding can be controlled by the use of epinephrin or serum, it is possible to study the urine free from blood, and for this purpose can be recommended in every case. With this method there is always the danger of masking the one symptom hemorrhage, while a possible malignant or tuberculous process is left unrecognized to progress. In dealing with such a case of unknown pathology these procedures are to be condemned unless the patient can be kept under our control and constant observation. When the conservative treatment fails, or the bleeding has existed for several months with a resulting anemia coupled to an uncertain diagnosis, then we believe that surgery should be resorted to without delay.

CONCLUSIONS

In our study of three human and six experimental cases we have demonstrated definite lesions in the medulla as the exciting factor, and believe that the term "essential" as applied cannot be maintained.

In our cases the following sequence of events has apparently taken place in the pathology of the kidney.

1. An infection which has been localized to foci in the medulla; no areas of infection have occurred above the corticomedullary junction.

2. The repair of these infected areas by the formation of dense masses of connective tissue.

3. This fibrosis has produced an obstruction to the venous return from the medulla and papillae through the venulae rectae.

4. As a result of this obstruction, varicosities have developed which not only appear in the substance of the papillae and just under the epithelium covering the papillae, but finally rupture on the free surface of the papillae and discharge their blood.

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We hope that this work will help to clarify the true cause of these so-called cases of symptomless hematuria, and believe that other men will report similar findings if their cases are studied from the point of view here recorded.

ABSTRACT OF DISCUSSION

Dr. Hubert A. Royster, Raleigh, N. C.: Dr. Payne has discarded the term "essential." The more we study disease the less use we have for such terms. I am sure Dr. Payne is correct in assuming that this condition of hemorrhage from the papillae does form a certain percentage of the unexplained cases. In regard to the etiology, there may be many and various factors to consider. The term nephritis is just as little understood today as it was some years ago and the expression nephropathy which the essayist used is probably as good as any to cover all the shades of etiologic meaning. Now what may be some of the causes back of the so-called nephropathies? In the first place alcohol and other toxic agents may cause a one-sided nephritis just as well as a bilateral nephritis. It may be taken for granted that these agents could produce an affection in one kidney without affecting the other kidney. Concerning the pathology, Dr. Payne is probably on the right track. In many cases it may not be possible to demonstrate any pathologic change whatever. In other words, there may be no organic evidence of bleeding; but, if one can discover uniformly such changes as have been described, it might be possible to solve the problem. Given, then, a case of one-sided bleeding from the kidney, what shall we do about it? We must not overlook the very important point, that is, the possibility of an early tuberculosis in every case of bleeding kidney. I agree that decapsulation is to be condemned, but if it gives the results reported it might not be harmful. I remember the incision of the capsule to relieve pain and in some cases it also relieves hemorrhage. I would suggest that, in cases where nephrotomy has been done, and nephrectomy decided not to be done, instead of closing the kidney with sutures we might, as I have done in two instances, wrap it up in a bundle as we do a package. Instead of having needles going through after being sliced up, wrap the kidney together by catgut as you would tie up a bundle. Finally, if most of us had such a case as described by the author we would undoubtedly institute conservative treatment until the actual cause was demonstrated, except in the extreme cases referred to by him.

Dr. J. Shelton Horsley, Richmond, Va.: This question of essential hematuria has worried all of us who do general surgery. Of course, many cases of renal bleeding are due to stones, to tuberculosis, to hypernephroma, but there remains

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a group which would have been difficult if not impossible to explain. Dr. Payne's sections show the pathology beautifully and also how easily the lesion might be overlooked. The section through the cortex showed perfectly normal structure. The papillae give the pathognomonic feature of the disease. It is common to find inflammatory lesions in the cortex where we would expect them, particularly in hematogenous infection or nephritis which occurs from toxic material in the blood. It is comparatively rare to find lesions in the papillae, but at the same time they do occur there as Dr. Payne has demonstrated. The section showing a dilated vein bleeding seems to be conclusive. This corresponds with pathology elsewhere, for instance, dilatation of the veins in cirrhosis of the liver. Inflammation produces scar tissue which constricts the veins and causes them to dilate distal to the constriction. In regard to the treatment, I have just one observation to make and that is to recall some excellent work done by Moore and Corbett regarding the type of sutures to be used for nephrotomy. They show that while the mattress suture controls hemorrhage it tends to destroy the kidney substance by necrosis, and they recommended simple interrupted sutures lightly tied.

Dr. R. L. Payne, Jr., Norfolk, Va.: There is no question that many of these cases are bilateral, and one kidney may bleed at one time and one at another. It is very probable that the focal infections we have observed in the kidney follow along the line described by Eisendrath, namely, some lymphatic infection. The pathology we see in these slides shows vessels with free blood, some with clotted blood, some with hyaline degeneration; in some organization has occurred. These vessels originally dilated before occluding and organization later began in the vessels that bled when finally ruptured. That is probably the explanation of how some of these vessels bled and eventually wound up with an ultimate cure by organization and that will, in addition, explain how decapsulation helps to cure them. When you decapsulate, the handling causes trauma which produces a condition favorable to thrombosis, and that is probably how decapsulation cures. The condition is really self-limiting in the bulk of the cases.

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NAIL EXTENSION IN FRACTURES OF THE LOWER EXTREMITY

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NEW YORK

In most fractures of the lower extremity, the well established methods of immobilization by plaster cast or of continuous traction by Buck's extension or Hodgen's suspension will prevent shortening. Open operation is rarely indicated—in less than 5 per cent.—according to Darrach, with whom I fully agree.

There is a definite group of exceptional cases in which none of the aforementioned procedures are applicable; here, nail extension has proved of value. According to this method, continuous traction is applied to the ends of a steel nail transfixing the lower fragment at a point well away from the site of fracture (Figs. 1, 2, 3 and 4). The nail is removed at the end of from twenty-eight to thirty-five days. As a rule, by this time there is enough callus to prevent shortening. Needless to say, introduction and extraction of the nail are performed under anesthesia and with the strictest aseptic precautions. I have already fully described[1] the details of technic.

Nail extension has been preeminently valuable in the following conditions:

1. *In recent simple fractures with extensive abrasions so that a cast or Buck's extension, etc., is contraindicated.* The following case will serve as an example:

CASE 30.—O. T., a boy of 6, had been run over by an automobile, April 26, 1915. He was admitted to Mount Sinai Hospital to the service of Dr. Edwin Beer. There were frac-

1. Gerster, J. C. A.: Am. Jour. Med. Sc., August, 1913, p. 157.

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tures of both femurs at their middle, and extensive abrasions of thighs, legs and feet. Small areas of intact skin remained just below the knees. Infection of the abrasions over the right thigh led to infection of the underlying fracture hematoma (as shown by high fever on the seventh and eighth days); the abscess was drained at midthigh and buttock on the ninth day (Fig. 5).

Knowing my interest in such cases, Drs. Beer and Elsberg kindly permitted the patient to be transferred to the latter's service (the Third Surgical Division) at this time.

On the eleventh day (May 7), nail extension was temporarily applied to both tibiae below the knees (for position see Figure 1). By making traction directly upward, the thighs were kept vertical, thus preventing purulent discharges from seeping into the nail holes. The knees were flexed at right angles and the legs were suspended by suitable loops in a horizontal position. Figures 6 and 10 show the condition of affairs three weeks later (May 28); there is no shortening on the right side, but considerable overlapping on the left.

After twenty-three days of extension (May 30), the abrasions of the lower parts of the thighs had healed. Accordingly, a second pair of nails was made to transfix the femurs just above the condyles, and those through the tibiae were withdrawn. Figures 7 and 11 show nails in the typical supracondylar position; there is no shortening (June 7). A little over three weeks later (on the forty-sixth day of extension and twenty-fourth day of supracondylar extension, June 23) there was firm union of the left femur; extension on this side was discontinued.

The compound fracture on the right side consolidated much more slowly, so that the nail was not removed until the thirty-seventh day after its application (July 6, seventy-one days after fracture). There was no sequestration. Two weeks later (July 20) all wounds had healed, but, as the child was backward in learning to walk, he was kept in the hospital twenty-two days longer (being discharged, August 11, 107 days after fracture). Figures 8 and 12 taken August 5, show the fractures firmly healed. Six months later (Feb. 3, 1916) there was firm bony union (Figs. 9 and 13).

It is well not to employ nail extension in any one locality for longer than about thirty days; in this case additional time for traction was gained by utilizing two sites of attachment in succession.

During the early part of the treatment (from the eighth to the twenty-second days of extension) when traction was still applied to the tibiae, I was absent, and it so happened that undue traction on the right side produced a moderate subluxation of the knee and

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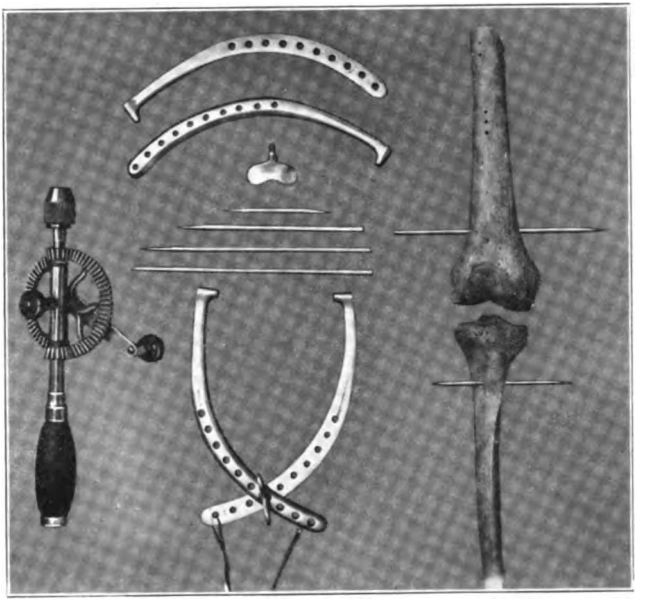

Fig. 1.—Instrumentarium; nails, hand drill and tongs assembled and taken apart; femur and tibia transfixed by nails in typical positions.

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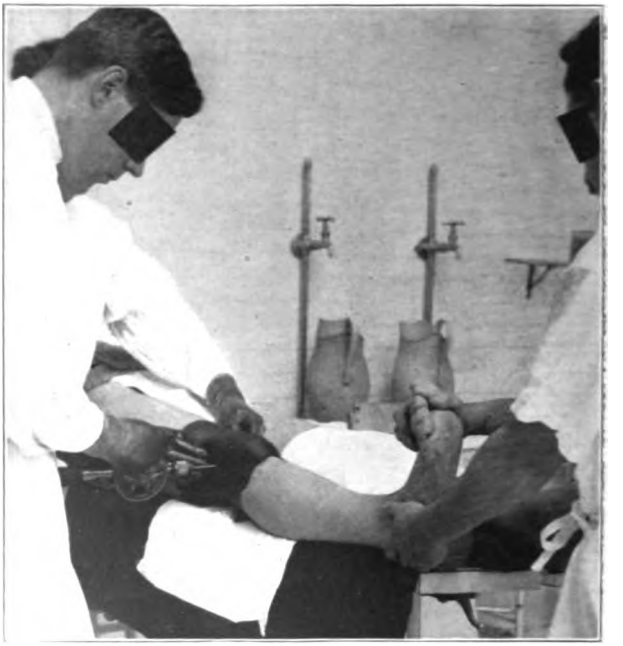

Fig. 2.—Insertion of nail. The patient's hip, knee and ankle lie close to the margin of the table. One assistant grasps the foot (holding its outer margin vertically) and exerts traction. Another assistant, whose left arm and hand are clearly seen in the picture, pulls upward on the skin of the thigh. The nail penetrates the soft parts one finger's breadth above the upper margin of the external condyle. Nitrous oxid anesthesia is maintained during the brief period required for drilling through bone and soft parts.

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Fig. 3.—Application of occluding dressing (begun). The projecting nail ends transfix heavy pads of sterile gauze, which can be seen turned aside to expose the nail just where it emerges from the skin. After aristol (thymol iodid) and collodion are applied, the gauze is replaced and covered by a bandage.

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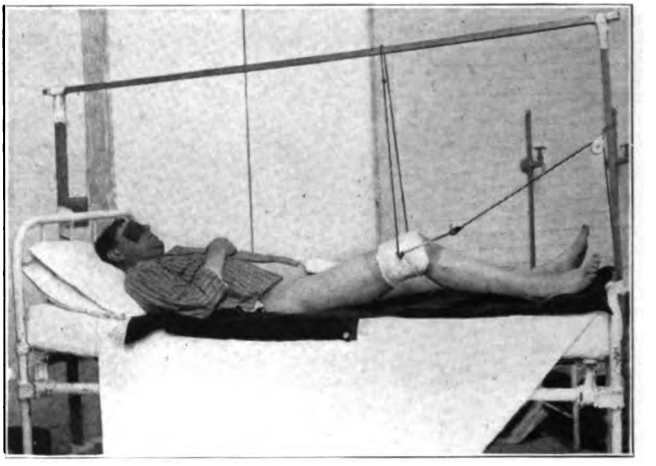

Fig. 4.—The traction exerted through tongs and rope suffices to keep the thigh suspended in semiflexion; suspension of nail ends to the overhead bar is mainly to prevent rotary displacement. For the sake of simplicity, the subsequent suspension of the foot (to barely clear the bed) has not been shown. From this illustration it can be seen that wounds of the leg or foot can be dressed without disturbing traction on the thigh.

Fig. 5 (Case 30).—May 6, 1915, ten days after fracture of both thighs. Extensive abrasions precluded application of a cast or any form of adhesive plaster extension. The fracture hematoma on the right became infected and was drained at midthigh and buttock.

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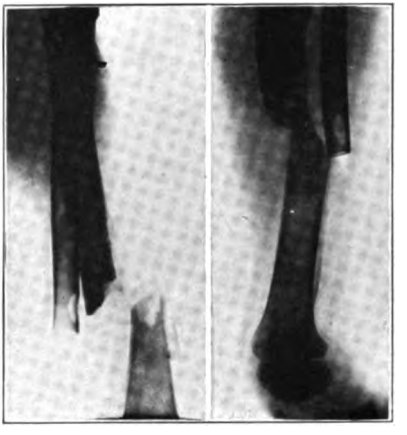

Fig. 6 (Case 30).—May 28, twenty-one days after nail extension. Right femur, anterior (*a*) and lateral (*b*) views. Compound fracture drained by tubing.

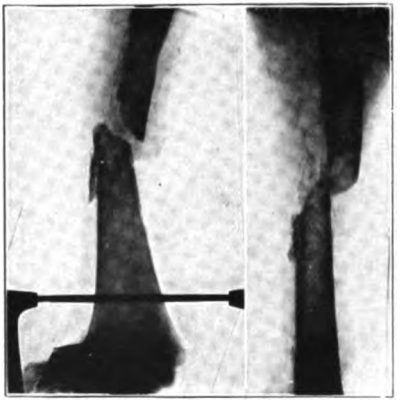

Fig. 7 (Case 30).—June 7, thirty-one days after extension. Right femur, anterior (*a*) and lateral (*b*) views. Note nail in typical position.

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Fig. 8 (Case 30).—August 5, ninety days after extension. Right femur, anterior (*a*) and lateral (*b*) views. Wound healed; there was no sequestration.

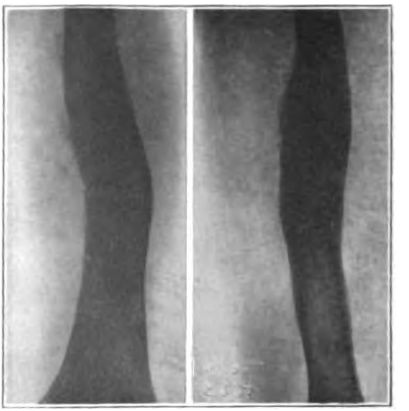

Fig. 9 (Case 30).—Feb. 3, 1916. Right femur, anterior (*a*) and lateral (*b*) views.

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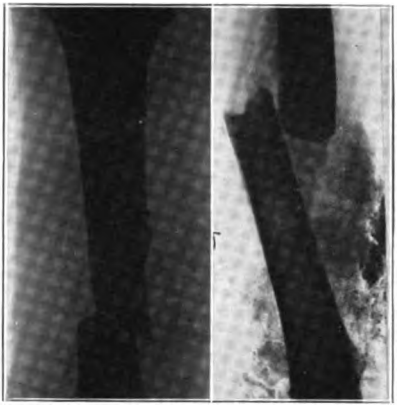

Fig. 10 (Case 30).—May 28, 1915. Left femur, anterior (*a*) and lateral (*b*) views.

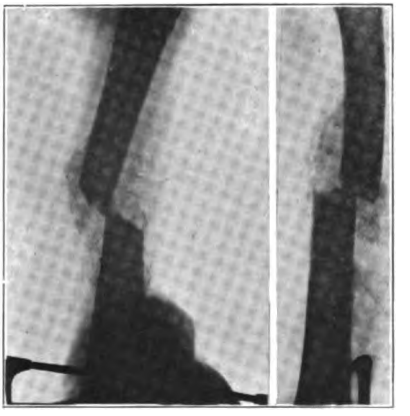

Fig. 11 (Case 30).—June 7. Left femur, anterior (*a*) and lateral (*b*) views.

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Fig. 12 (Case 30).—August 5. Left femur, anterior (*a*) and lateral (*b*) views.

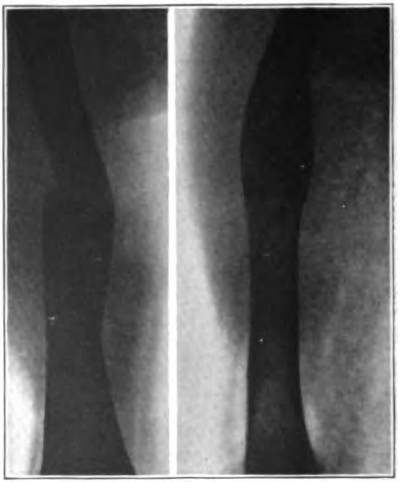

Fig. 13 (Case 30).—Feb. 3, 1916. Left femur, anterior (*a*) and lateral (*b*) views.

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Fig. 14 (Case 30).—June 1, 1916. Good function; no limp; right femur shows one-half inch lengthening.

Fig. 15 (Case 23).—Feb. 21, 1914. Fracture of the lower third of the right femur, anterior (*a*) and lateral (*b*) views (nail through tibia).

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Fig. 16 (Case 23).—March 28, 1914. Anterior (*a*) and lateral (*b*) views.

Fig. 17 (Case 25).—Feb. 21, 1914. Fracture of both bones of the leg, anterior (*a*) and lateral (*b*) views.

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Fig. 18 (Case 25).—March 5, 1914. Anterior (*a*) and lateral (*b*) views. Note location of nail in calcaneus.

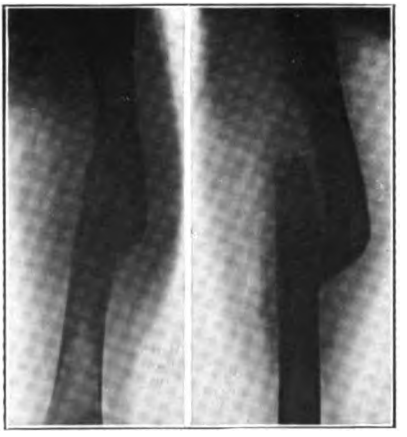

Fig. 19 (Case 29).—Malunion of right femur four months after fracture; anterior (*a*) and lateral (*b*) views; 2¼ inches shortening.

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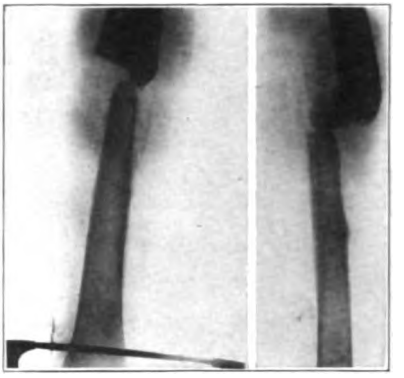

Fig. 20 (Case 29).—March 22, 1915, after seventeen days of nail extension following osteotomy reestablishing the fracture.

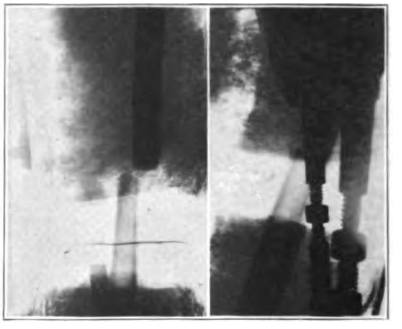

Fig. 21 (Case 29).—April 9, thirty-five days after operation. Delayed union; reduction of fragments maintained by distracting halves of plaster cast with Hackenbruch's turnbuckles (the cast was cut across at the level of the fracture. Anterior (*a*) and lateral (*b*) views.

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Fig. 22 (Case 29).—April 28, fifty-four days after operation. No shortening; no angulation; a massive callus. Anterior (*a*) and lateral (*b*) views. Patient was sent home shortly after (May 11) in an ambulant hip splint.

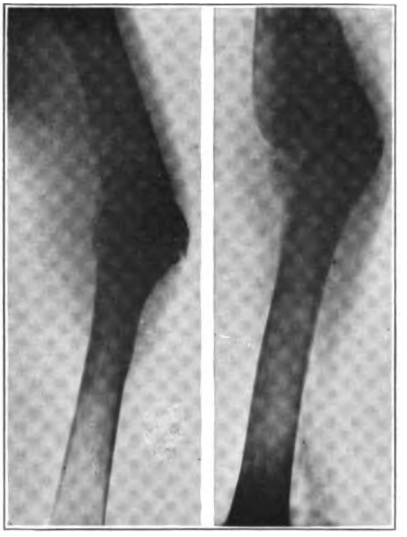

Fig. 23 (Case 29).—July 8, 1916, one hundred and twenty-fifth day after operation. Patient had absented himself from the clinic for more than eight weeks in spite of repeated instructions to report for observation and control. Both anterior (*a*) and lateral (*b*) bowing had taken place. The parents refused permission for any operative attempts at correction, but consented to a prolonged stay in a convalescent orthopedic hospital in the country.

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Fig. 24 (Case 29).—Jan. 21, 1916. Anterior view, six months later; firm bony union; one-half inch shortening.

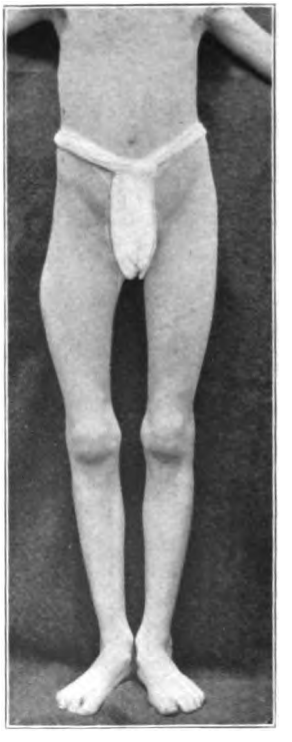

Fig. 25 (Case 29).—June 1, 1916. Good function; moderate angular deformity; one-half inch shortening.

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overdistraction of the femoral fragments (Fig. 6). Some shortening followed relaxation of traction (on the twenty-third day), but it was not sufficient to make the legs equal and this side remained half an inch longer. There was no permanent relaxation of the knee joint; a slight but very persistent limitation to full extension, however, lasted for many months, which finally yielded after prolonged immobilization in plaster. The child is now (June 1, 1916) without a limp (Fig. 14).

In this connection it is well known that undue traction on the leg will produce a subluxation of the knee joint. Such a complication can be avoided only by most careful management. Figures 15 and 16 show reduction of an oblique supracondylar fracture of the femur in a woman of 35 (Case 23) by nail extension applied to the head of the tibia. Similar applications of traction in three other cases (3, 4 and 10) have likewise shown no ill effect on the knee. It is my opinion that traction on the semiflexed knee joint is less harmful than on the fully extended joint, the ligaments of which are already stretched to their full extent.

Figure 17 shows a fracture of both bones of the leg in a woman of 45. (Case 25, Knickerbocker Hospital, service of Dr. H. D. Collins). By the end of four days, so many blebs had developed that a cast was out of the question. Nail extension for twenty-two days resulted in a satisfactory reduction (Fig. 18). There was no delay in union.

2. *In recent compound fractures with much destruction of the soft parts,* nail extension has proved of value, especially during the first few weeks, when suppuration is at its height. The patients derive great comfort because the wound can be dressed and the bedclothing changed without disturbing the fracture. The method has found favor with some of the American surgeons now working in France.[2] According to

2. Fauntleroy, A. M.: Medico-Military Experiences of the European War, 1915.

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Dr. Hermann Fischer of the German Hospital, New York, the German surgeons are making extensive use of the method.

3. *In multiple injuries to the same limb,* the method affords innumerable opportunities for improvisation. A railroad employee (C. H., Case 9) had sustained a comminuted fracture of the femur and a crushed foot. A glance at Figure 4 will show how dressings of the injured foot were made without disturbing the traction on the femur (Polyclinic Hospital, service of Dr. J. A. Wyeth, Nov. 22, 1912).

In another case there was a fracture of the upper third of the thigh and a comminuted fracture of both bones of the leg just above the ankle. There were many abrasions of the thigh. Supracondylar nail extension prevented shortening of the femoral fracture, and a plaster cast immobilized the comminuted fracture of the leg. The knee joint was passively exercised several times a day (G. O., Case 28, City Hospital, B. I., service of Dr. H. D. Collins, Sept. 19, 1914).

4. *In fractures of several weeks' standing with much shortening,* nail extension or open operation constitute the only means by which reduction of fragments may be accomplished. Eight of my own cases belong in this class. Nails were inserted as late as twenty-one days after fracture and often after fourteen days. Previously, for some reason or another, the proper routine treatment had not been carried out, and the patients were seen for the first time (on their admission to the hospital) with shortenings of from 1½ to 3 inches.

In addition to the extremely effective and relatively comfortable traction, the daily passive motion of the knee joint (in supracondylar insertions) has been a great advantage. Steinmann also recommends daily massage of the fractured thigh after the first week, but I have not been in a position to give this a trial.

The favorable results in this group are so well known that illustrative case histories are superfluous.

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5. *Old Malunions.* Heretofore anything like complete correction of shortening has been impossible. When such malunions were exposed at operation, the upper end of the lower fragment was found so friable that no screw or other fixation contrivance could find any hold—the bone could be pared like cheese; moreover, the longstanding contraction of the soft parts made complete reduction impossible. The surgeon was therefore obliged to content himself with partial resection of both ends and alinement of the fragments; shortening was inevitable.

Now, with nail extension at his disposal, the surgeon can reestablish the fracture by chiseling the fragments apart, saving every bit of the friable lower fragment. He then can close the wound and apply nail extension. In a few days the shortening of months is overcome. Some delay in union is to be expected; even if this goes on to nonunion, it can be remedied by bone grafting with reasonable probability of ultimate success.

Case 29.—G. H., a boy of 13, sustained a fracture of the middle third of the right femur, Nov. 5, 1914, for which he was treated at another hospital.

Feb. 27, 1915 (three and one-half months later), he was admitted to Mount Sinai Hospital (service of Dr. Elsberg) with a firm union and a shortening of 2¼ inches (Fig. 19).

March 5 (four months after fracture), he was subjected to operation. This consisted in (*a*) insertion of a nail in the supracondylar position by myself and (*b*) osteotomy for malunion by Dr. W. M. Brickner. The contracted soft tissues resisted reduction of the overlapped fragments even after the division of the cicatricial tissue in the soft parts adjacent to the site of fracture. The wound was closed in layers. Traction was begun with 14 pounds; within five days this was gradually increased to 23 pounds.

March 22 (seventeen days later), there was no shortening (Fig. 20).

April 3 (twenty-nine days after operation), a cast was applied with Hackenbruch distraction clamps incorporated in the plaster; ample fenestrae were left around the projecting nail ends.

April 7 (thirty-three days after operation), the cast was divided opposite to the point of fracture and the halves were distracted by the Hackenbruch turnbuckles until the nail

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remained immovable when traction was relaxed (for there was still no union in spite of a good callus).

April 9: Figure 21 shows the distracted halves of the plaster cast maintaining reduction of the fragments.

April 28 (fifty-four days after operation), the cast was removed; there was a large callus, and union was good in a satisfactory position (Fig. 22).

May 11, the patient was sent home in an ambulant splint. There was no shortening or angulation.

For over eight weeks after this the patient failed to report at the hospital in spite of repeated requests and notices. Finally under threat of coercion by the Gerry society, the boy's parents brought him for inspection, July 8. There was considerable angulation with consequent shortening (Fig. 23). Operative correction of the deformity was flatly refused. The child was accordingly sent to an orthopedic hospital in the country to insure his being under constant competent supervision. Here he remained under the care of Dr. C. L. Wallace for six months.

A roentgenogram taken ten months after operation (Jan. 21, 1916) shows sound bony union with no increase in deformity (Fig. 24).

June 5, 1916, one and one quarter years after operation, there was good function (no limp), some deformity and ½ inch shortening (Fig. 25). Needless to say, had he remained under constant supervision (as instructed), angulation could in all probability have been avoided.

Objections which have been raised against the method are:

1. *Pain.*—If the skin of the thigh is pulled upward while the nail is being inserted, there should be no pain after the nail is once in place, firmly embedded in the bone. On the other hand, if the skin is not pulled upward during the insertion, later when traction is applied, the nail presses against the skin just below it, there is constant pain, and a decubitus results.

2. *Infection.*—The danger of infection is nil, provided: (*a*) the strictest asepsis is observed, and (*b*) Steinmann's precepts regarding sites of insertion are followed. These are: (*a*) avoidance of the hematoma around the fracture[3]; (*b*) avoidance of the marrow cavity; (*c*) avoidance of the joint cavity, and (*d*) avoidance of the epiphyseal line. According to these

3. The only deaths attributable to the nail extension have followed infection of the fracture hematoma from the improperly placed nail tract passing through it (Steinmann).

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tenets, therefore, in fractures above the lower third of the femur, the nail is inserted at a point 1 finger's breadth above the upper margins of the condyles just behind the middle line of the bone (Figs. 4, 7, 11 and 20). In fractures of the lower third, the site of insertion is a point on the tibia 2½ fingers' breadths below the upper margin of the tibia on a level with the lower margin of the head of the fibula (Fig. 1). In fractures of both bones of the leg in its upper half, the nail transfixes the tibia 2 fingers' breadths above the ankle joint, or 3 fingers' breadths above the malleoli. Lastly, in fractures of both bones just above the ankle, the nail point perforates the calcaneus 1½ fingers' breadths below and behind the malleoli (Fig. 18).

The few infections which I have observed have followed either lack of asepsis, or attempts to improve on the original method. Steinmann uses a sharp pointed nail which is driven through skin, subcutaneous soft parts and bone, and is then left in situ. In the forepart of his book, written in 1912, Steinmann[4] expressly condemns incision of the soft parts so as to expose the bone; he also deprecates drilling a hole first and later inserting the nail into it. In spite of his warnings that such unnecessary procedures increase the chances of infection, and, indeed, have been followed by local infections, certain surgeons in this country have repeated the errors of their European colleagues and, I understand, their patients have suffered from bone sinuses in consequence. I therefore advise any prospective inventor to peruse the beginning of Steinmann's monograph, not only to discover the various modifications already devised, but also to learn the defects of these questionable improvements.

In my own series (thirty cases) the nail holes through tibia or calcaneus were as dry on the day of removal as when they were made. The same was true of most of the femur cases; in quite a number of the

4. Steinmann: Nagelextension der Knochenbrüche, Neue deutsch Chir., 1912, i (Steinmann is an assistant of Kocher's in Berne).

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remainder a drop or two of pus was present around the nail at the time of withdrawal, there had been no fever previously, there was no inflammation of adjacent soft parts at the time and the holes healed completely under the customary wet dressings in a week or ten days.

The only case of my personal series with infection resulting in prolonged suppuration and a persistent bone sinus followed displacement of occluding dressings. There was perfect function of knee and no shortening.

I have never seen an infection follow the withdrawal of the iodin-painted nail point through the nail tract, and lay no stress on the theoretical objections raised about this procedure. The metal of the nail and the adjacent skin must be thoroughly cleansed of crusts or dried collodion, and well impregnated with iodin before extraction. Afterward tincture of iodin is injected into the nail tract from both sides, and an aseptic wet dressing is applied. This is changed daily under the strictest asepsis until the holes are filled with granulation tissue; then they are covered with a mercurial ointment dressing until healing is completed.

Lastly, I do *not* advocate nail extension as a routine method of treating fractures. However, there can be no question about its being a most valuable addition to the older, well recognized procedures.

CONCLUSIONS

1. Nail extension is a safe measure, provided the proper technic is employed.

2. Because of its small site of attachment, it is of great value in recent simple fractures with extensive abrasions, in recent compound fractures with much destruction of soft parts, and in multiple fractures of the same limb.

3. Because of its efficient traction, in conjunction with osteotomy, it is the only method whereby the

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shortening present in certain old malunions can be safely overcome even months after the original fracture.

4. In relation to open operative reduction, it may be stated that in certain cases nail extension will obviate the necessity for operative intervention, and in others can be employed to prevent shortening until the suitable time for plating has arrived.

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NAILS AND SCREWS THROUGH JOINT SURFACES, IN AUTOGRAFTS AND IN FRACTURES INTO JOINTS

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Last year, before the Western Surgical Association, I reported a series of experiments to determine the response of the tissues of the joints to nails and screws inserted through the joint surfaces. The present series was undertaken to find out what this response would be in the presence of autografts in the joints and of fractures into the joints.

Various degrees of detachment of the fragments, from partial separation and separation from all but one crucial ligament, to the free autograft were used. The results were uniformly successful in all cases in which the pieces of bone were fastened firmly, and in all cases in which they were fixed in a faulty position and not quite securely. Only one case failed to show an apparently perfect result, with free, smooth motion of the knees, with the dogs running and jumping about so well that they had to be caught and the legs examined before one could tell which leg had been operated on. This dog was one of the autograft cases in which the graft had been fastened with a small, round brad, so loosely that the condyle could be moved rather easily in a swivel arc about the brad. It was not able to catch up its new blood supply and the entire graft of the condyle of the femur was absorbed, as was also some of the opposing surface of the tibia which had not been touched by the operation. These irregular surfaces were already covered over with connective tissue which looked like cartilage, at the end of two months, the time of the experiment.

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In all, twelve dogs were used. No joint in this series or in the series reported last year showed infection, though the simple iodine sterilization, and no dressings was used in all. The time varied from one month and thirteen days to three months and five days from operation to the recovery of the specimens. The fixation of the fragments varied from firm to loose, and they were set in positions varying from accurate to one of moderate displacement. The nails and screws were set at different levels, some projecting, some flush with the cartilage, and some buried.

The results were surprisingly good. All fragments, except the loose one spoken of above, were firmly united to the femurs. The autografts were united with a callus as firm and thin as were the ordinary fractures, and the grafts themselves apparently remained as living pieces, of full size, and covered with their normal cartilage. The microscopic sections, however, show that their trabeculae are being replaced cell by cell by new bone growing inward from their vascular margins, and that the cartilage continues to live. The nails and screws in the autografts were covered, or nearly covered, with new connective tissue looking like cartilage. This was true, also, in the partially detached fracture cases. In the latter specimens some of the nails and screws had been left projecting above the surface somewhat, and, in these, the groove which they had cut in the patella was covered with new cartilage.

A remarkable tendency was shown in the condyle, in these cases, to grow until the surface tended to equal or to exceed the level of the projecting nail or screw and thus to prevent any further injury to the joints. At the same time the opposing groove shows a tendency to build up somewhat, though not to the normal level.

REPORT OF EXPERIMENTS

EXPERIMENT 1 (906).—Right knee, three months, five days after operation (Figs. 1 and 2). Knee opened inside, after a fracture had been made with a chisel, through a separate

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linear incision at or near epiphyseal line. Considerable amount of hemorrhage was found in the joint from the fracture.

A 1¼ inch screw was used through inner condyle into shaft of femur, the external half of which projected just above the cartilage surface, and its posterior edge was a short half millimeter above cartilage surface. The internal half of screw was sunk very slightly below surface level; joint was freely swung before suturing to cut the groove in the patella, and three layers of interrupted linen were used.

The specimen (Fig. 1) shows firm union with a little excess of callus; condyle built up over the level of the screw head; screw covered; fibrous band of adhesions from tissue over screw head to synovial sheath just below patella; no signs of the blood left in the joint.

Broad groove on patellar surface, scratched by screw head, is fairly smooth, with a lining of cartilage. Cartilage surface on femur is remodeled somewhat to fit the new contour of the patellar surface, apparently largely by upbuilding.

Transverse section, Figure 2, through the groove on the patellar surface, shows cartilage even in the thinnest portions with new bone building up into it, continuous with the bone below, and, in spots, almost to the outer surface of the cartilage, that is, the groove is building up as the screw head is withdrawn from contact by the building up of the condyle.

Experiment 2 (908).—Left knee, three months, four days after operation (Figs. 3, 4 and 5). Left hind leg broken at or near epiphyseal line by a chisel; same as in Experiment 1, except the fracture was more free, and apparently left attached only to small amount of periosteum. It was freely movable in all directions.

A 1½ inch screw was used through the surface under the patella, buried at its lower edge 2 mm. into the bone. On its anterior edge it projected about 0.8 mm., but before it was quite sunk to this level, the joint was freely moved so that the screw head cut a groove in the patella. These fragments of bone and cartilage were largely left in the joint. The screw held the fracture fairly well in place; it allowed a fair amount of rotary motion, judged not sufficient to spoil the experiment; a second screw was not inserted, because of the relative size of screw now in joint.

Joint filled with hemorrhage from fracture. Wounds sutured as before in three layers over joint, two over site of fracture. Linen used.

The specimen (Fig. 3) shows firm union in slight displacement; no signs of the bone chips remain; no signs of the blood left in the joint.

Growth of the condyle has raised the surface to the level of the screw margin; screw head almost entirely covered with connective tissue looking like cartilage, all except a slight streak at the edge.

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Patellar surface, broad smooth groove cut by screw head fairly evenly lined with cartilage.

Transverse section through patellar groove (Fig. 4) shows bone growing upward into the cartilage, and in many places farther along, it has come to the surface in its endeavor to fill up the groove as the screw head was withdrawn by the building up of the condyle.

Transverse section through the tissue covering the screw (Fig. 5) shows connective tissue, a reversion of the cartilage to connective tissue over connective tissue derived from the bone spaces.

Experiment 3 (911).—Left knee, two months, fifteen days after operation (Fig. 6). Knee fractured with chisels, through longitudinal incision. The line of fracture went through upper surface of articular cartilage, over which the patella moves; fragment was made free from all periosteum, though still attached to some of the ligamentous tissues throughout part of its circumference. Joint opened along inside of patella, which was dislocated outward; fragment fastened into place with two furniture nails, the inner one buried 2 mm. at shallowest point, 3 mm. at lower edge, on account of oblique surface of joint. The other nail was buried 1.5 mm. at lower edge and about flush with cartilage surface at upper edge. Joint closed with three layers of linen.

There was a considerable amount of blood left in the joint. Specimen (Fig. 6) shows firm union with slight displacement, noticeable only at the cartilage line; slight growth of connective tissue fastened to the cartilage at this line.

Anterior nail, covered with connective tissue and nearly smooth; posterior nail, nearly covered with connective tissue; condyle has built up somewhat so that the edge of the outer nail is now below its surface.

Patellar groove is lined with cartilage, but shows that the nail opposite used to project somewhat.

Section transversely through the groove on the patella (Fig. 6) shows cartilage growing, with bone formation beneath, to lessen the groove.

Experiment 4 (913).—Left knee, two months, six days after operation (Fig. 7). Left knee opened as before. Fracture made ⅝ inch lower than upper edge of the articular surface with a flap of cartilage and bone, averaging 1 to 3 mm. in thickness and on the surface of a full ¼ inch, loosened from surface of fragment; the lower fragment entirely separated from periosteum, but attached to soft parts, throughout part of its circumference. This was fastened by two furniture nails driven through the surface under the patella, but not quite in perfect line; the outer nail very slightly below the joint surface. The inner nail projects 1 mm. above the joint surface.

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Three layers of sutures; moderate amount of blood in joint. Joint moved up and down to make necessary groove on the patella to correspond with the projection of the inside nail.

Specimen (Fig. 7) shows firm union; partial absorption of the small flapping fragment; condyle apparently slightly built up to decrease the elevation of the nail and its surface changed to accommodate itself to the changed groove scratched in the patella. Patellar groove not yet covered with cartilage. Otherwise, joint surface smooth.

Transverse section through patellar groove shows bone growing so rapidly to fill up the groove that there is almost no cartilage over it.

Experiment 5 (916).—Left knee, two months, one day after operation (Fig. 8). Left knee opened as before; fracture a little over ½ inch below edge of cartilage; periosteum completely severed. Two nails were inserted; the inner nail head buried well into the bone under cartilage surface 3 mm. deep; the outer nail head buried 2 mm. Fragment rotated inward before fastening.

Suture; three tiers, sutured as before. Considerable blood was left in the joint.

Specimen (Fig. 8) shows firm union in its new position. Nails completely covered with connective tissue, nearly smooth; opposing surface smooth; no signs of the blood left in the joint.

Experiment 6 (924).—Left knee, two months, twenty days after operation (Figs. 9 and 10). Incision over internal aspect of left knee anteriorly; internal condyle fractured with a chisel and entirely loosened from surrounding tissue, so that it was held only by one crucial ligament alone for its blood supply. This was rotated outside of the joint to make sure; on returning to place, there was a persistent tendency toward internal rotation of the posterior portion, so that it was difficult to place it in correct position, though this could be done.

The fragment was fastened by one furniture nail through articular surface slightly above the cartilage, with moderate tipping of the whole fragment, so that the lower surface was bent farther from the middle line of joint than normal; this apparently held fragment fairly firm in position. The cartilage surface which had been cut across was matched at the inner anterior margin, but the twist left the outer anterior margin (mesially) projecting about 2 mm. above corresponding cartilage of upper fragment and at a distance of 1 mm. from it. The nail head was left just above cartilage level posteriorly, but only very slightly.

The joint was sutured in three layers, interrupted linen sutures; moderate amount of blood left in joint.

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Specimen (Fig. 9) shows firm union in its new position of slight rotation with a fine line showing in the cartilage. The projecting edge of the fragment under the patella is smoothed down to fit the patellar surface, but is covered with cartilage.

The nail is completely covered with a thin layer of connective tissue, nearly smooth.

Transverse section through condyle and line of union shows the line of union complete, but cartilage edge of the union shows fibrocartilage.

The fragment (Fig. 10) has behaved like an autograft, and shows microscopic replacement of the bone trabeculae taking place at all margins. Bone cells in the centers of the trabeculae are gone, the cell spaces empty. This is a little more noticeable as the distance increases from the line of union. This corresponds with the microscopic regeneration of the autografts. The circulation through the crucial ligament has been insufficient to keep the fragment living.

The articular cartilage has kept its vitality and has undergone no apparent change, except that in some places, and to a moderate degree it seems to contribute to the microscopic replacement of new bone in some of the trabeculae nearby.

There is the tendency toward the formation of fibrocartilage in a vertical arrangement at the line of union. The bone of the line of union is nearly indistinguishable from that of the bone of the shaft near it.

Experiment 7 (926).—Left knee, autograft of condyle, two months, one day after operation (Figs. 11 and 12 *d*). Left knee was opened as usual; external condyle chiseled free from bone and separated from crucial ligament and all the soft tissue, and finally removed from the joint to be sure that it was a free autograft, then fastened into place by two furniture nails, so that the upper edge of each nail is buried 1 mm., the lower edge 2.5 to 3 mm., below the cartilage surface. Apposition at line of fracture good, but condyle slightly rotated; fair amount of blood in joint. Joint sutured in three layers as before; linen sutures.

Autograft (Fig. 11) shows perfect union in its new position of slight rotation; apparent living of entire autograft; cartilage surface smooth and normal; no atrophy of condyle; nails covered; crucial ligament not united.

The roentgenogram (Fig. 12 *d*) shows autograft, nails and line of union.

Transverse section (Fig. 13) shows microscopic growth of new bone replacing the bone trabeculae in the autograft, taking place at practically all margins from the vascular spaces inward. Bone cells in the centers of the trabeculae are gone and the cell spaces are empty. The general contour of the trabeculae are preserved by the new growth. There is no open space between the new and the old.

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The articular cartilage remains practically unchanged, except that in places it seems to contribute to a small degree to the replacement of new bone in some of the adjoining trabeculae. At the line of union there is a tendency toward fibrocartilage with a vertical arrangement.

EXPERIMENT 8 (928).—Left knee; autograft, two months, four days from operation (Figs. 14 and 12 *a*). Left joint opened as before; two holes drilled before internal condyle was broken off with a chisel, and removed from joint after separating the crucial ligament (that is, a free graft). The fragment was replaced; two furniture nails driven so that the edges toward median line of knee were very slightly below cartilage level, though almost of the level, the outer edge deeper.

Joint full of blood when sutured in the usual way. Position of fragment almost exactly normal.

Autograft (Fig. 14) shows perfect union, so smooth that a faint line can just be made out on the cartilage; entire graft apparently has lived.

Anterior nail covered; posterior nail nearly covered, all but one edge; no evidence of the old blood in the joint; cartilage on the opposing tibial surface nearly smooth, not quite; semilunars normal; crucial ligament not united.

The roentgenogram (Fig. 12 *a*) shows autograft, nails, and line of union.

Transverse section through autograft and line of union (Fig. 15) shows the microscopic replacement of the bone trabeculae in the autograft from the vascular spaces at practically all margins, with the bone cells in the centers gone and the spaces empty; the general contours of the trabeculae preserved; almost no distinction between the trabeculae in the line of union and the living bone attached to the shaft; the articular cartilage practically unchanged except that it contributes somewhat to the new bone formation. At the line of union there is a change toward fibrocartilage with a tendency toward vertical arrangement.

EXPERIMENT 9 (933).—Left knee; autograft, empty drill hole, two months, seven days from operation (Figs. 16, 12 *c* and 17). Incision into left knee as before; drill hole with countersinking for screw; a second drill hole was made anteriorly with the countersinking and left open; fracture of internal condyle, which was removed from joint to be sure that it was a free graft; screw inserted after replacing the fragment. Line of union excellent, a small partially detached fragment was left on posterior portion of bone graft; joint sutured as before.

The screw head was just above level with the cartilage surface toward middle of joint; it cleared about 2 mm. at opposite edge.

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Autograft (Fig. 16) shows perfect union, no atrophy; cartilage smooth; entire graft apparently has lived; the loose tag of the fragment has also smoothly healed in place; screw, outer portion more than half covered with new tissue.

Opposing joint surfaces are smooth and normal except a slight loss of the semilunar surface now healed over. The empty hole is entirely filled with new tissue.

The roentgenogram (Fig. 12 *c*) shows autograft, screw and line of union.

Section (Fig. 17) is through autograft and line of union, and includes the filled hole. This shows the microscopic replacement of the trabeculae in the autograft as in the preceding specimens and the same unchanged condition of the cartilage with its moderate contribution to the new bone formation and its tendency toward fibrocartilage in vertical arrangement at the line of fracture.

The hole has been filled apparently by growth from the living bone below, very little from the bone and cartilage in the autograft. It is covered with connective tissue, the upper layer from hyaline cartilage changed through fibrocartilage to connective tissue, the lower layers from the connective tissue growing out from the vascular bone spaces.

Experiment 10 (935).—Left knee; autograft, filled hole; two months after operation (Figs. 18 and 19). Left knee joint was opened as usual; two holes drilled and the internal condyle chiseled off and separated from all soft tissue, including the crucial ligament, removed from the joint and replaced. The joint was small; there was considerable difficulty in getting the fragment perfectly true; a screw hole with countersunk margin was left open; a second opening for a nail made and a small brad inserted; fragment in excellent position and apparently stayed in place moderately on manipulation, but easily moves in a swivel arc about the brad. Head of nail sunk well below surface of cartilage. Joint full of blood when closed.

The specimen (Fig. 18) shows that the loose autograft has entirely disappeared. The surface left is pitted and irregular. Evidently there has been a definite osteoclasis sinking it below its original level. Two small spicules project from its surface. These and the remaining surface are covered with connective tissue which looks like cartilage. The opposing tibial surface is likewise partly absorbed and pitted, but covered with modified cartilage. Part of the semilunar cartilage on the opposing surface of the tibia is absorbed, leaving only fragmentary portions still in place. A small area on the other condyle also shows irregular absorption, but here the semilunar cartilage is intact.

The patellar surface shows some absorption with fairly smooth upbuilding of modified cartilage of a slightly changed color.

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Section through the irregular surface of the femoral condyle shows some microscopic destruction with osteoclasts and Howship's lacunae, with here and there some new bone growth. This area is covered with connective tissue, derived in part from the cartilage by reversion through fibrocartilage to connective tissue and in part from the connective tissue of the bone spaces.

Figure 19 shows the cartilage changing toward new bone in one direction and toward connective tissue in the other.

The section through the tibial surface shows similar changes, though the osteoclasts here seem to be mostly single cells, while in the femur there are more which suggest the multinuclear type, and the connective tissue covering is thinner in places and in spots the surface is bare.

Experiment 11 (937).—Left knee; one crucial ligament attachment, empty drill hole; one month, thirteen days after operation (Fig. 20). Left knee joint entered as before; two screw holes with countersinking for the screw heads; lower hole left open, anterior one used for screw, after separation of internal condyle from all tissue, except the crucial ligament, which was left attached. One screw holds the condyle firmly, but in a position of moderate rotation, inward, of the posterior portion (that is, away from joint center), leaving a wedge-shaped fissure on the joint surface beneath the patella. Joint sutured as before, three layers.

The screw head lies nearly flush with cartilage of joint in its upper and inner half, buried 3 mm. in its outer edge (that is, away from joint center) just below the transverse line of screw head. Joint fairly full of blood when closed.

Specimen (Fig. 20) shows the fragment united like a free autograft. There is firm union in the position it was fastened, that is, in slight rotation; fracture line still moderately irregular; cartilage smooth; no absorption of condyle; screw head over half covered with new tissue; no overbuilding of the condyle, as the anterior edge of the screw is still about flush with the cartilage surface.

Semilunar cartilage opposite the screw on the anterior edge shows some fibrillation and a moderate loss of surface where the screw evidently rubbed it.

The empty screw hole is filled though not quite smooth, and is apparently covered with the same sort of tissue as the screw head. There is no evidence of the blood left in the joint.

Section of the condyle, the line of union and the filled hole show the same microscopic replacement of the trabeculae. The circulation through the crucial ligament is so minute that, with this attachment alone, the condyle unites like a free autograft. The hole has been filled largely by bone from the shaft fragment from below, with very little from the detached condyle, and the covering is connective tissue,

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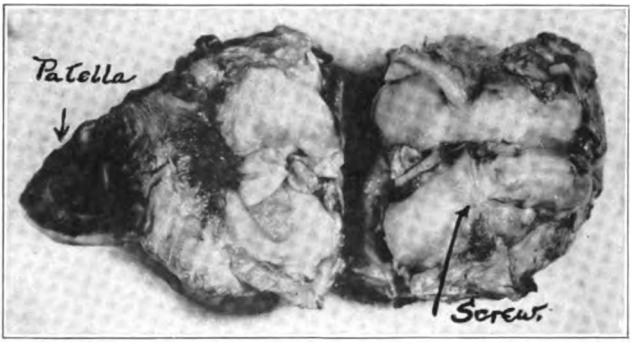

Fig. 1.—Fracture; screw projected slightly; three months five days after operation, condyle built up, screw covered. Patellar groove lined with cartilage.

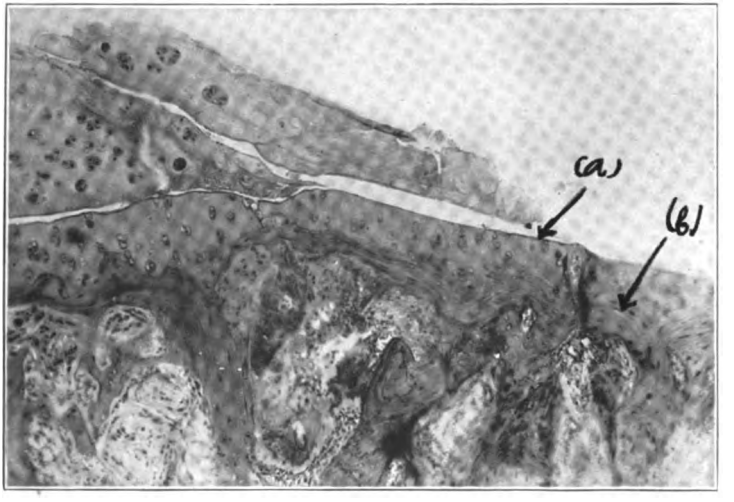

Fig. 2.—Patellar groove lined with cartilage (*a*) and filling up with bone (*b*).

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Fig. 3.—Fracture; screw projected 0.8 mm.; three months, four days after operation, condyle built up, screw covered except slight streak at one edge, patellar groove lined with cartilage.

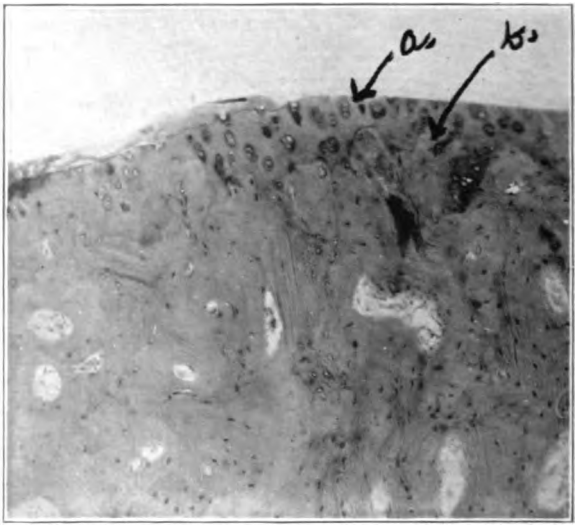

Fig. 4.—Patellar groove lined with cartilage (*a*) and filling in with bone (*b*).

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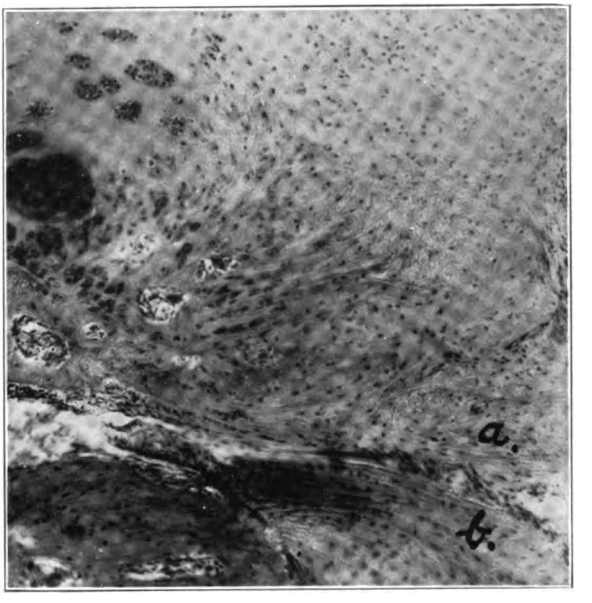

Fig. 5.—Tissue covering screw; a reversion of cartilage to hyaline cartilage and then to connective tissue (*a*) overlaying connective tissue derived from the spaces between trabeculae (*b*).

Fig. 6.—Fracture; two nails; two months fifteen days after operation, anterior nail covered with connective tissue, posterior nail nearly so, patellar groove covered with cartilage.

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Fig. 7.—Fracture; two nails; one was projecting 1 mm.; two months six days after operation, condyle slightly built up, projecting nail nearly level, patellar groove so rapidly filling with bone that there is almost no cartilage over it.

Fig. 8.—Fracture; two nails, buried; two months one day after operation, nails covered with connective tissue.

Fig. 9.—Condyle left attached to only one crucial ligament; one nail projected slightly; two months twenty days after operation, firm union, condyle built up, nail covered with connective tissue.

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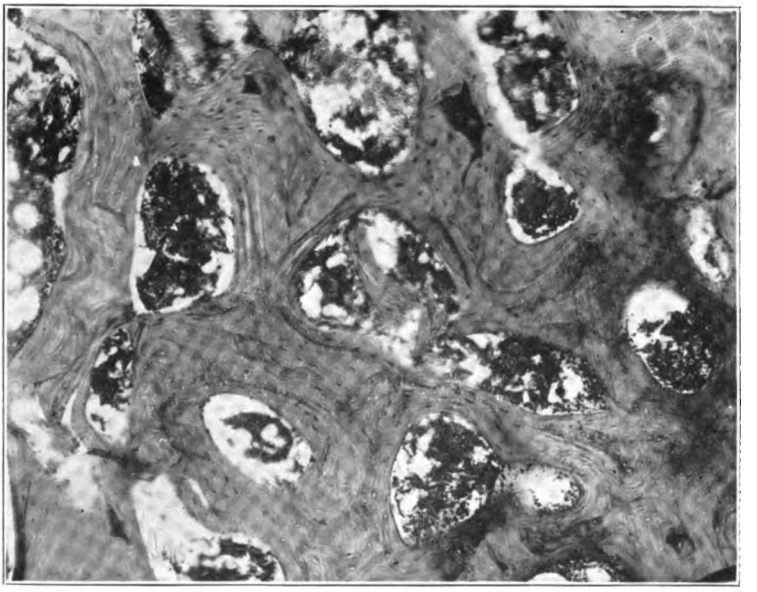

Fig. 10.—Transverse section through fragment; high power; condyle has united like an autograft, with microscopic replacement of bone.

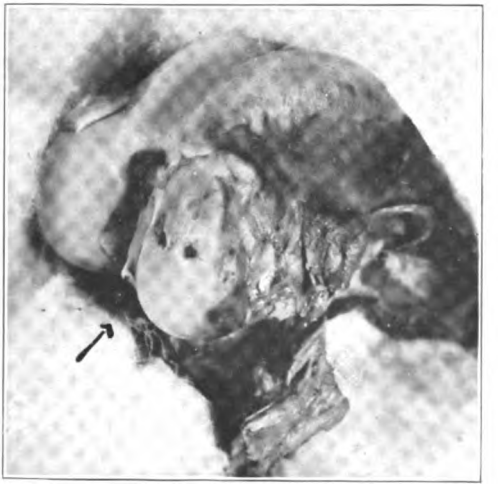

Fig. 11.—Free autograft of condyle; two nails; two months, one day after operation, perfect union, no atrophy of condyle, crucial ligament not united.

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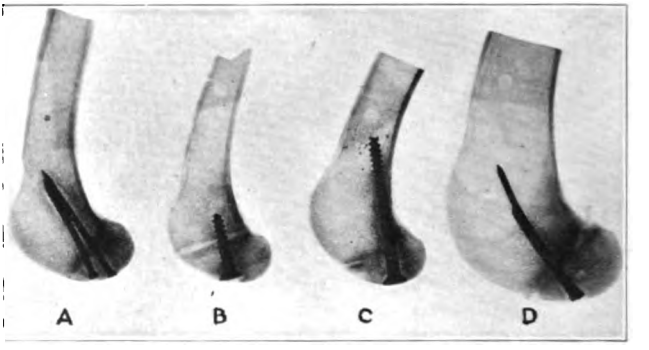

Fig. 12.—*a*, autograft, nails and line of union; *b*, fracture, screw and line of union; *c*, autograft, screw and line of union; *d*, autograft, nails and line of union.

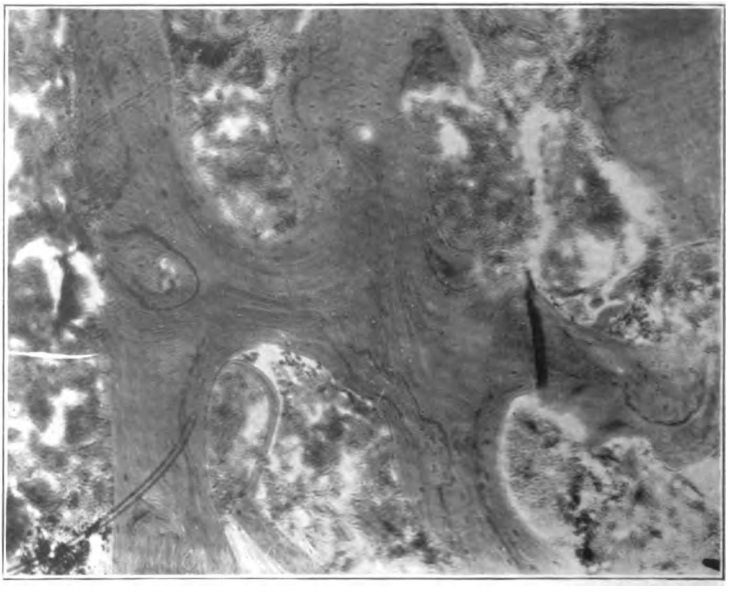

Fig. 13.—Transverse section through autograft, high power; shows microscopic growth of new bone replacing the bone trabeculae in the graft.

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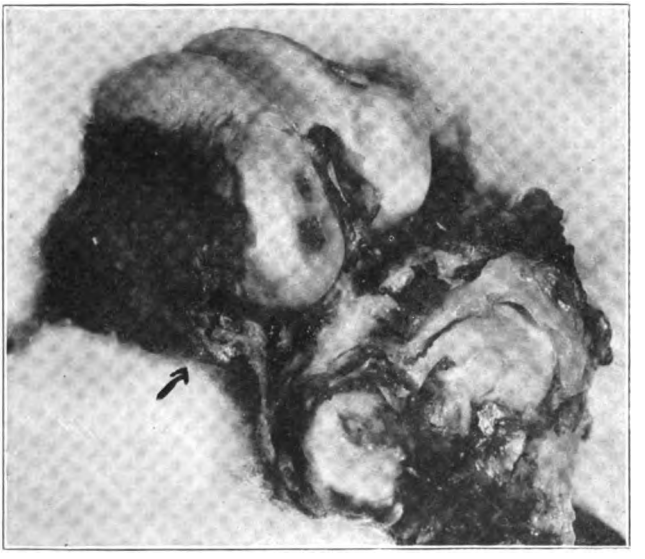

Fig. 14.—Free autograft of condyle; two nails; two months, four days after operation, perfect union, anterior nail covered, posterior nail nearly so, crucial ligament not united.

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Fig. 15.—Transverse section through autograft, high power; shows microscopic replacement of the bone trabeculae in the graft.

Fig. 16.—Free autograft of condyle; screw projected; drill hole left empty; two months, seven days after operation, perfect union, no atrophy, screw more than half covered, empty hole almost entirely filled.

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Fig. 17.—Transverse section through autograft, high power; microscopic replacement of trabeculae (without the preliminary formation of cartilage and without the intervention of special osteoclasts).

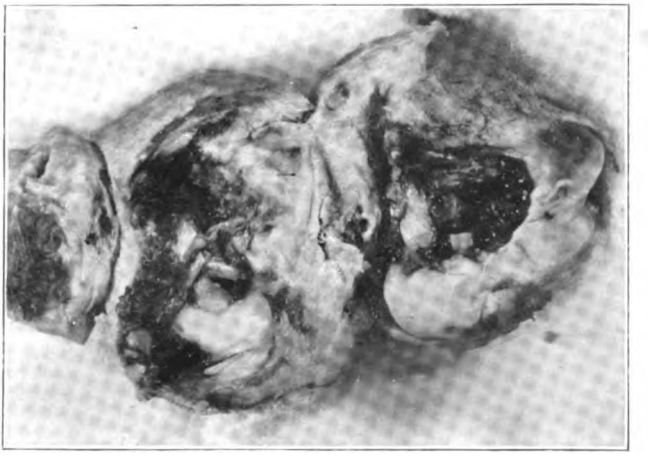

Fig. 18.—Free autograft of condyle; small brad allowing swivel motion of graft; two months after operation, graft entirely absorbed (not able to catch up its blood supply); some absorption also on tibia and on patella.

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Fig. 19.—Transverse through surface of absorbed condyle shows cartilage changing toward new bone (*a*) in one direction and toward connective tissue (*b*) in the other.

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Fig. 20.—Condyle left attached to only one crucial ligament; screw; empty drill hole; one month thirteen days after operation, firm union, no absorption of condyle, hole filled but not quite smooth.

Fig. 21.—Fracture, both condyles; screw; empty drill hole; one month twenty-five days after operation, firm union, hole filled, screw three fourths covered.

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Fig. 22.—T fracture with one condyle stripped free.

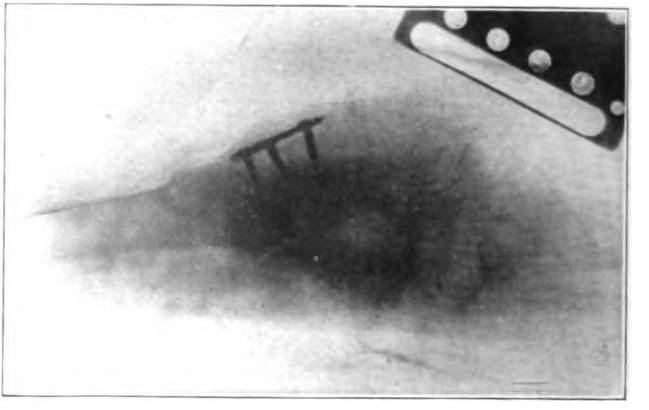

Fig. 23.—Autograft of condyle in place and fractured condyle fastened.

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Fig. 24.—Cast just removed; three months; knee movable.

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a reversion of the hyaline cartilage to the connective tissue type over connective tissue growing from the vascular spaces.

EXPERIMENT 12 (942).—Left knee, one month, twenty-five days from operation (Figs. 21 and 12 *b*). Left knee opened as before; chisel fracture, both condyles in one piece, about 1 inch back of anterior edge of cartilage; one ordinary drill hole ¼ inch deep anteriorly, not entirely through the fragment on internal condyle, was left empty, as a blind pocket; one ¾ inch screw used to fasten fragment in place.

Fragment came into good position, except a separation of nearly 2 mm. along the inner line of fracture, where chisel had been inserted, a distance of about ¾ inch in length; approximation along cartilage under patella quite good. Joint full of blood when sewed with three layers of sutures in the usual way.

Specimen (Fig. 21) shows firm union with a fine line; empty hole filled; screw three quarters covered over with connective tissue.

The roentgenogram (Fig. 12 *b*) shows fragment, screw and line of union.

Section (Fig. 21) through filled hole, condyle and line of union shows that the trabeculae in the condyle have lived; new trabeculae in the line of union formed from both fragments. The small empty hole has filled with bone, largely from the loose fragment, which is almost indistinguishable from the surrounding bone, and because small, is covered with cartilage, nearly all of it fibrocartilage running vertically.

REPORT OF CASES

To this series of animal experiments I wish to add two cases in the human being, one in an elbow and one in a knee. The elbow was reported with my previous series.

CASE 1.—A fractured and misplaced fragment of the external condyle of the humerus in a boy of 7, persistently resisted all the usual methods of replacement, and six weeks after the fracture the fragment stood out from the joint with a rotation of nearly a half circle. The slight attachment to a small strip of the external lateral ligament suggests the experiments in which a condyle of the knee was loosened from all attachment but the crucial ligament, and which united to the shaft like a free autograft. The slight attachment apparently was sufficient to prevent its gross absorption, but no callus was found, six weeks after the injury, at the time I saw the case, opened the elbow and nailed the fragment with two small furniture nails through the joint cartilage. The joint was held in acute angle flexion at first, and, later, a few connective tissue adhesions were broken up under ether. This loosened the fragment somewhat, but the final

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result was a good serviceable joint with moderate limitation of motion at the extremes of motion.

CASE 2.—This was a free autograft of the external condyle of the knee in a Syrian girl, aged 13, who had been knocked down by a motorcycle and run over from her feet upward. This resulted in crushing of the left foot, a fracture of both bones of the right leg, a compound fracture of the pelvis through the vagina, and a badly displaced T fracture into the left knee joint (Fig. 22). The crushing of the foot resulted in a necrosis of the little toe and most of its metatarsal; the fracture of both bones of the leg and the compound fracture of the pelvis healed nicely.

The girl was in marked shock. When this wore away she was given ether, and an attempt was made to set the T fracture into the knee. The roentgenogram, later, showed the fragments as badly out of place as before. Then in an open operation, the inner condyle was replaced and fastened with a Lane plate. Through a second incision the external condyle was felt to be loose and finally rolled out into my hand, a free autograft.

This made a tight fit in its natural position after a few jagged edges toward the shaft side had been trimmed with bone forceps. The soft parts sewed over it fastened it so securely into place that no nails or screws were used. Owing to the original crushing of the soft parts and possibly to some dried scabs, there was a streptococcus infection in the wound over this fragment which extended well up the thigh and gave temperatures over 103, which after a number of days slowly subsided. The discharge lessened but did not stop.

One month after the operation I determined to find out what conditions existed, and gave the patient ether, removed the cast, and explored. My fingers finally came down on a bare corner of the autograft in the lower branch of the sinus. I thought it wise to leave the graft in place, even if it came out later, as I expected it to do, so that if possible there might be some mold of new bone formed about it which might fill in later after the autograft came out. On looking the leg over I noticed a pouting sinus over the calf with a grayish slough in its opening. I pulled on this, and gradually the whole gastrocnemius muscle came out in one piece.

A few days after operation the discharge lessened, and after some time the wounds finally healed, with the graft still in place (Fig. 23).

At the end of three months from the first operation the last cast was removed (Fig. 24), and the girl is now walking with a movable knee which can be flexed almost up to her thigh. The Lane's plate is still in place. Although no nails or screws were used to fasten the free condyle into place,

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I have thought it proper to report the case in connection with this series of experiments which it inspired.

The remarkable thing about this case is not only that the free graft of the external condyle lived and gave a useful knee, but that it lived in the presence of an infection of a distinctly violent type and that the Lane's plate is still in place. The fissure leading to the plate must have granulated in sufficiently to have closed the plate from the field of the infection.

CONCLUSIONS

1. The autografts unite with a line of callus as fine as those of simple fractures, with a free joint, and without adhesions.

2. The autografts seem to live, but in reality the bone trabeculae are gradually replaced by microscopic bone growing inward from the vascular spaces between them, while the cartilage continues to live and to a limited extent aids in the formation of the new bone adjacent to it.

3. The main replacement of the bone in the trabeculae seems to take place directly from bone cells without the preliminary formation of cartilage, and the dead portions of the trabeculae seem to be absorbed in a line immediately adjacent to the new growing bone without the intervention of special osteoclasts.

4. Condyles detached from all tissue save the crucial ligament unite like free autografts.

5. Condyles, attached more or less to other tissues as well, continue to live throughout, or nearly so.

6. Nails and screws are tolerated in the human being as well as in the experimental cases, and with surprisingly little reaction. They remained firmly embedded in every specimen recovered, but the Roentgen ray shows a slight thinning of the bone about them.

7. The surface covers with connective tissue, a reversion of the cartilage from hyaline to fibrocartilage and then to connective tissue, which overlays connective tissue derived from the vascular spaces between the trabeculae.

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8. The response of the condyles to the presence of a rigid body projecting above the joint surface is to build up the condyle in its attempt to withdraw it, and prevent further injury to the opposing joint surface. This also takes place when the condyle is an autograft.

9. This growth is a true growth of bone, and the cartilage tends to retain its normal thickness.

10. The groove cut by a projecting nail or screw, in the opposing surface, covers over with hyaline cartilage, and the groove tends to fill up with bone as the projecting body is withdrawn by the growth of the condyle.

11. The line of fracture in the cartilage tends to cover over with cartilage, largely of the fibrocartilage type if it is narrow, with connective tissue if it is wide.

12. In autografts, empty drill holes fill with new bone, growing up from below, only to a very limited degree from the bone and cartilage in the graft; in living fragments, from the trabeculae of the fragment, very little from the cartilage. The surface covers with the same kinds of connective tissue as do the nails and screws.

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ABSTRACT OF DISCUSSION

ON PAPERS OF DRS. GERSTER AND MANN

Dr. Charles E. Thomson, Scranton, Pa.: Fracture of the neck of the femur is very badly treated, if, indeed, it is treated at all. We complain that the profession has introduced theories that as these patients are mostly old it would be better not to treat them. I think that many of our bad results have been brought about by two traditional fallacies, first, that the neck of the femur would not unite as other bones do, and second, that the proper thing to do with a fracture any place in the femur was to place the body on an inclined plane and hang a weight some place on the broken limb and call it Buck's extension. Buck's extension at best is a misnomer; in practice and principle it is wrong, and as generally used it is a farce. Since reading my last article before this section I have had upward of a hundred cases treated by Whitman's method and with one single exception I have obtained good functional results.

Dr. R. H. Sayre, New York: Why are these fractures in general treated so badly? It is because the medical profession does not take any interest in them. The profession is much more interested in surgery of the abdomen, surgery of the thorax, sutures of the heart, and odds and ends of that kind instead of common things like fractures. It seems to me that with the coming of the Workman's Compensation Act a great deal more attention will have to be paid to fractures if we expect to escape malpractice suits. When the insurance companies have to pay the bills of these people with damaged legs instead of their being treated in hospitals for nothing they will expect a much better result than a great many of them at the present time receive, and as they wander around through eight different medical examiners and hear incidentally the opinions expressed by these eight different medical examiners as to the benefit they have derived from their treatment, they will sometimes become peevish and seek the courts.

If it is a fact that we can drive tacks and brads into joints without disturbing their function, it is a wonderful thing to know. I am extremely glad to hear that we can treat joints with so much more impunity than I had supposed was possible, and I shall look for these cases with very great interest in the future. It would seem to me that that last case of the child with the supracondylar fracture might perhaps have been a good case for the use of a Steinmann needle in the shin as a means of holding the fragments in position.

In these cases which are reported by Dr. Gerster, some of which I have seen, I think that the Steinman pin has given most excellent results. There is no question but that it has a very distinct function in the treatment of fractures where

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you wish to make traction and hold fragments in position and yet have no suitable skin on which to make traction. I believe there are certain cases where it is a distinct aid to our present mode of treatment.

Dr. H. H. Albee, New York: I, too, was a little astonished that joints would survive metal being driven into them. In my own practice I cannot bring any experience to bear on these procedures. I have used bone graft pegs. It seems to me that it is preferable to put this metal in a position where it can be removed with little difficulty if it ever gave trouble. We must consider not only the immediate but the remote danger of infection. In reference to fractures of the neck of the femur I would remove the bone graft from the crest of the tibia with the motor saw. We must get as perfect a fit of the graft as possible. These pegs can be made of any size and it is that type of peg that I have been using in place of the nails and screws that Dr. Mann has mentioned. The reasons we do not get union are: First, mechanics; second, faulty blood supply; third, meagre osteogenesis; fourth, the danger of an early callus formation. I would not remove the head of the femur until the last ditch was reached. The bone graft fixes equally as well as the nail and it stimulates osteogenesis.

Dr. James T. Watkins, San Francisco: The abduction treatment of hip fractures is the application of a surgical principle to a single joint. That is, fractures about joints should be put up always in that posture which is the most difficult for that joint in health to assume. Extreme abduction is the posture which the hip in health finds most difficult to assume. That is the broad underlying principle recognized by orthopedic surgeons, and perhaps we can persuade our surgical friends to adopt this treatment.

Epiphyseal separation occurs practically invariably in children from 13 to 15 years of age, and especially in exceedingly fat children. When they come to us for examination there is a slight shortening, some outward rotation, and they cannot raise the leg to any extent.

Dr. W. R. MacAusland, Boston: In treating fractures of the long bones or about the neighborhood of joints we should remember that the human body is like a machine that works in certain fixed and irrevocable lines. As we see a fracture for the first time our first object should be to return function as soon as possible and to avoid confinement in bed; first, to prevent the atrophy from disuse; second, to enable the patient to regain function early. Dr. Whitman has outlined the principles and those who follow his advice carefully and faithfully need rarely resort to any operative interference whatsoever. In fractures of long bones alignment is most important, more from the orthopedic than the surgical standpoint. Limitations of joint motion and deformities all have

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after-effects which disable and make the patient inefficient. Dr. Gerster has outlined his method in the use of nail traction. My objection to it is the length of time it demands confinement in bed. Then comes the question of which way the pendulum is now swinging on the operative treatment of fractures. In the last ten years we have seen a distinct wave of operative enthusiasm in these acute fractures. We have seen the promiscuous use of bone plating and have seen disastrous results in the hands of many surgeons. Conservative treatment of fractures still is a very fertile field. Given, for example, 100 cases of fracture in our clinics there is no question that 65 to 80 per cent. can be treated and get perfect functional results by conservative treatment when followed out properly. But only in a certain percentage of cases, about 20 per cent., is operative interference indicated. I strongly oppose the use of metal in contact with bone. Some time or other it will suppurate. What are we going to use in these cases where operative interference is indicated, which is, as I said, a small percentage. The technic demands careful asepsis, avoidance of handling the skin and approaches to fracture. The cavity of the fracture can be sponged out with gauze and dried and the serrations of the fragments fitted together accurately. Then put it up in plaster. The advantage of this procedure is that there is no metal in contact with bone which will delay union, and the fracture is firmly held in an ambulant splint. These cases unite early with very little callus, the fractures healing mainly by internal and not by external callus.

Dr. Charles A. Parker, Chicago: I wish to commend the Whitman dressing for fracture of the neck of the femur. Two or three points are to be considered that have not been mentioned today. One is that there is an interference with abduction by the adductor muscles, so that the trochanter may not hit the upper part of the acetabulum. If you take the skeleton and abduct the thigh with the foot rotated outward, you rotate around the axis of the neck of the femur instead of getting true abduction. The important part of the whole treatment is to fix the bone in a good plaster cast. Rotate the foot inward as far as possible and put a plaster cast over the foot. Why does not the doctor follow the Whitman method? Because of the trouble with the plaster cast. In regard to the slipping fractures of the fat children: I may be entirely mistaken in the cases spoken of but in age and method of development, slowly developing with or without an injury, it is apparently a typical case of coxa vara adolescentium.

Dr. A. B. Fitch, Factoryville, Pa.: A patient of ours tripped on a carpet. The fracture was the same as Dr. Thomson's and he put it up after his method. I see that

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woman walking on the street almost every day and I think the result is perfect.

Dr. Leonard F. Schmauss, Alexandria, Ind.: We had many fractures of the neck of the femur at Cook County Hospital, Chicago; we treated them entirely with Liston's splint, which gives excellent results in fracture of the middle and upper part of the femur. But I was frequently disgusted when the splint was removed and I saw the subluxation or stiffness of the knee joint. In thinking over the matter I came to the conclusion that the cause of the trouble was due to the *method of extension.* Take raw adhesive strips, apply them to the limb and secure them with a snug bandage and then apply the weight. Where is the traction exerted? Practically seven tenths of it on the limb below the knee. The pull is from the limb below and around the knee joint — thus causing subluxation and stiffness — instead of from above, directly and mostly on the femur, as it should be. After recognizing this principle I left on the facing of the adhesive rubber below the knee and made the straps adhere to the thigh above only, thus preventing undue traction on the knee joint and in that way had no further trouble with subluxation and stiffness. If you follow this precaution you will have less occasion to use wire nail extension.

Dr. A. T. Mann, Minneapolis: This was an experimental study and I think it has brought out some exceedingly interesting things: in the ability of the joint to stand more damage than we usually think it can stand, the way the condyle fills up in response to a badly placed nail or screw, and in the way in which the replacements of autografts are made. I feel that it would seldom be necessary to place these nails and screws in the joints. Sometimes it may be a desirable thing to do. I think the experimental study shows some exceedingly interesting points.

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